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ENVIRONMENTAL ANALYSIS RECORD

FOR

GLASS BUTTE

GEOTHERMAL INTEREST AREA

CENTRAL OREGON

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Date: JUL 1976

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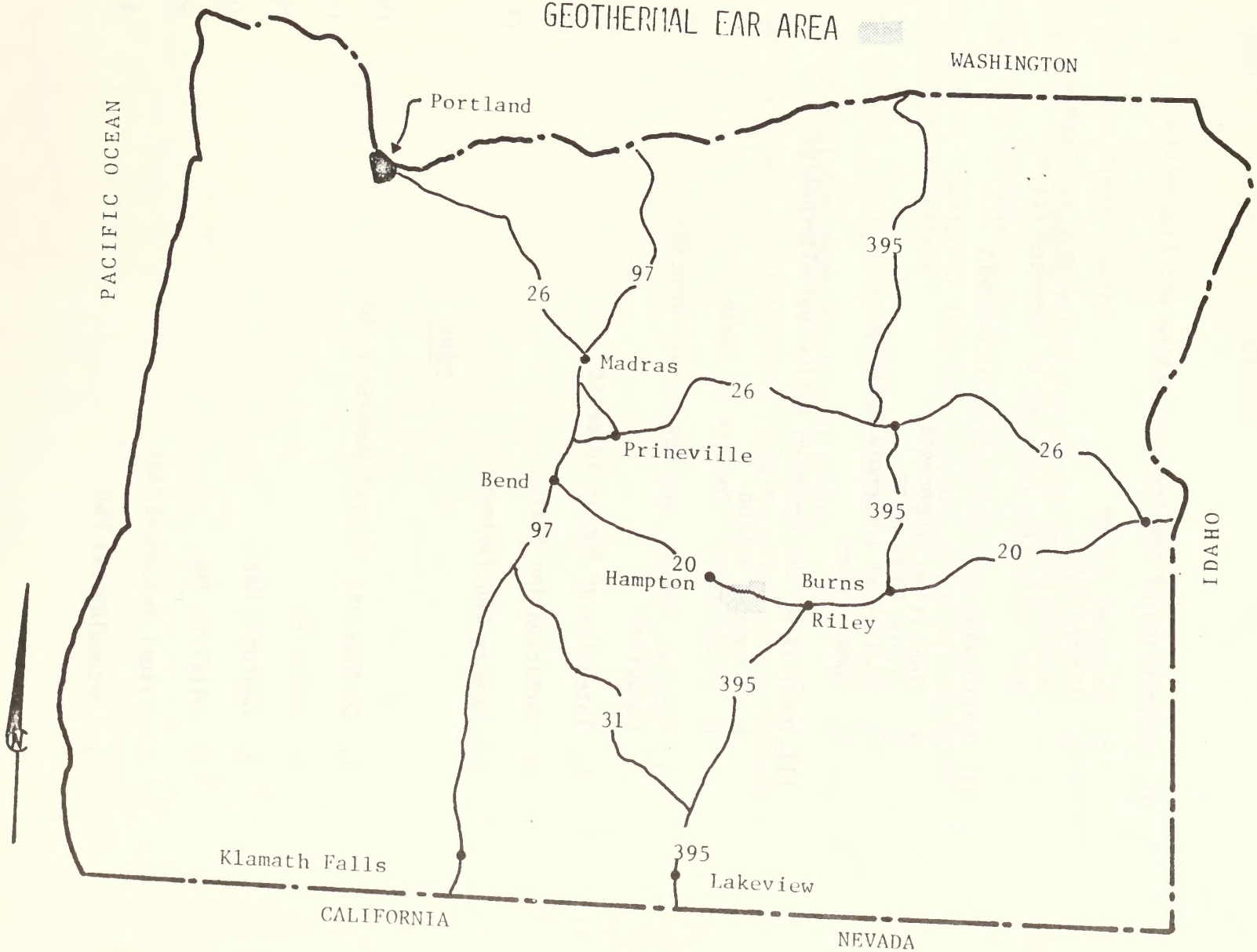
GLASS BUTTE GEOTHERMAL EAR AREA



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GLASS BUTTE AREA, CENTRAL OREGON

I. DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVE

A. Proposed Action

Lease federally-owned, potential geothermal resources for exploration and development pursuant to the Geothermal Steam Act of 1970 and regulations in 43 CFR 3200 effective January 1, 1974. These leases would permit exploration for, and development of geothermal resources if commercial reserves are found.

B. Alternative #1

Decline to lease Federally-owned, potential geothermal resources in the Glass Butte Area of Central Oregon.

C. Description of Geothermal Exploration and Development Activities Pursuant to Proposed Action

1. Geothermal Energy

Geothermal energy is the natural heat of the earth. Most of this heat is too diffuse to be generally recoverable. However, in some areas the heat has become concentrated close to the earth's surface so that areas are prospectively valuable for geothermal resource development. These "hot" spots are probably the result of a near surface magma (molten rock) chamber or a deep-seated magma connected to the surface by faults. These magma concentrations are generally located in areas of recent volcanism.

The heat energy is stored in rocks, water and steam. The water and steam are the vehicles of transport of the heat energy to the earth's surface. This heat concentration may or may not be manifested in hot springs and geysers. In some places the water and steam are trapped by overlaying impermeable rocks and there are no surface manifestations although these areas may be as valuable or more so than areas with hot springs.

2. Geothermal Systems

Two types of geothermal systems are considered to have present commercial application. They are differentiated on the basis of produced fluids.

a. Vapor-dominated Systems

This type of system is thought to contain both water

and saturated steam in the reservoir. When punctured by drilling, the pressure decrease in the reservoir causes the well to produce almost entirely dry steam. This steam may be used to directly drive a turbine. This type may be rare yet is the most desirable and economic system because less waste fluid is produced and more heat energy is available for power generation. Fields of this type currently producing are the Geysers in California, Larderello in Italy and Metsukawa, Japan.

b. Hot Water Systems

In this system, confining pressure holds water in a liquid state at temperatures above the atmospheric boiling temperature. When a well is produced the decrease in confining pressure cause a portion of the water to flash to steam and both water and steam are produced at the surface. At the surface the steam is directed to the generating plant and the water is handled as waste at the surface or injected back into the system. Production of this type is found at Cerro Prieto and Pathe, Mexico, Warikei, New Zealand and Otaka, Japan.

3. United States Geothermal Development

The Geysers in Northern California is the only large scale commercially developed geothermal field in the United States. Five electric generating plants operate from a vapor-dominated system and produce 400 megawatts of power. The ultimate, fully developed capacity is estimated to be between 1,000 and 3,000 megawatts.

4. Phases of Implementation

Four main phases of implementation are involved in the search for and development of geothermal resources. Progressively these are exploration, development, operation and close-out.

Each phase is interrelated with the success or failure of the preceeding. In practice, one phase will blend into or occur simultaneous with another. It would be common for exploration, testing and development to be taking place in one part of a field while production and even close-out might be taking place in another portion.

a. Exploration

The exploration for geothermal resources is designed to locate and define commercial geothermal reservoirs. Exploration activities, as they relate to surface damage, may be divided into five discrete operations. They are: (1) Airborne Exploration, (2) Off-road Vehicular Travel, (3) Road and Trail Construction, (4) Drilling, (5) Rehabilitation.

(1) Airborne Exploration

This operation may involve several techniques including:

(a) Aerial photography

(b) Infrared microwave imagery to detect heat or moisture differentials.

(c) Magnetic, using magnetometer to measure variations in magnetic fields.

(d) Gravity, using gravimeter to measure gravity variations.

These techniques produce no surface disturbance and only temporary negligible impact on air quality and noise levels.

(2) Off-Road Vehicular Travel

Generally, existing roads are used where possible, however, many exploration operations require off-road travel. These include:

(a) Geologic Mapping

Done by a field crew to determine structure, lithology and stratigraphy of an area. Small trucks or 4-wheel drive vehicles are used to transport the small crew.

(b) Geophysical Exploration

Gravity - ground gravity surveys involve obtaining gravity readings along a surveyed grid with a portable gravimeter. One or two small trucks transport the crew and equipment to the work area.

Magnetic - Magnetic variations are measured with a magnetometer and has similar field crew requirements to gravity.

Resistivity - The resistance of subsurface rocks to the passage of an electrical current is measured in the exploration method. Pulses of electrical current are induced into the ground through two widely spaced electrodes (usually about two miles apart), and recorded by small ceramic receivers placed at different locations. The electrodes are either short (2-3 feet) rods driven into the ground or aluminum foil shallowly buried over an area of several square feet. Two or three small trucks transport the crew of 3 to 5 men.

Telluric - A number of electrodes record the variations in the natural electrical currents in the earth. Small trucks are used to transport the crew in the field.

Seismic - A generated shock wave is recorded at various stations by geophones. The shock wave can be generated by truck-mounted vibrators, truck-mounted thumper or by explosives. In all three seismic methods, 5-7 trucks and 10-15 men are required. Surface mineral matter and vegetation must be removed from the energy generation sites and receiving sites to provide for proper sending and receiving. In addition, the explosive method may require road construction, and clearing of small areas for drill operation. A hole 100-200 feet deep is drilled with a small truck-mounted rig. The preparation produces minor surface disturbance, with the explosion causing minimal damage.

(c) Geochemical Surveys

Geochemical surveys of well and spring water are run to collect and analyze for chemical content. Occasionally small trucks are used to transport 2-3 men and equipment in the work area.

(3) Road and Trail Construction

For exploration activities utilizing large equipment in rough terrain with poorly developed access, roads are often constructed. These are temporary access

roads for such equipment as small drill rigs and water trucks and usually constructed to a very low standard. Where large drill equipment is to be used a much higher road standard may be used.

(4) Drilling

Includes seismic testholes, temperature gradient holes and geothermal exploration wells.

(a) Seismic test holes are 100-200 feet deep and drilled with small truck-mounted rigs. An area 30x30 feet is disturbed by the drill rig and water truck. No specific drill pad is built.

(b) Temperature gradient holes 300-500 feet deep are drilled with small truck-mounted rigs. An area 30x30 feet is disturbed by the drill rig and water truck. A capped pipe (usually 3/4 inch diameter) is placed in the hole and let stand for about a week. Then the temperature of the water in the pipe is measured to determine a temperature gradient.

(c) Exploratory well drilling would take place if there were encouraging results from earlier exploration efforts. Test wells would provide information concerning sub-surface geology, potential geothermal reservoirs and the properties of the reservoir fluids. Drill equipment would be similar to that used for oil and gas exploration wells. In most cases, depending on projected drill depths, the drill rig would have a conventional substructure which is put together on the drill site. The drill pad of from one to two acres is leveled and cleared of vegetation. Most equipment is located on this site. A reserve water or drilling mud pit of 1,000 plus square feet and 6 to 8 feet deep is usually necessary to hold waste fluids. A large drill rig or terrain features might necessitate construction of an improved road.

Blow-outs are uncommon, but can occur. They normally occur because of lack of specific knowledge of sub-surface characteristics of a geothermal field. Historically, blow-outs occur in 1-3% of the geothermal test and production wells. Geothermal blow-outs cause no fire hazard and are generally controlled by slant drilling and sealing with concrete. While the blow-out is taking place,

water, steam and contained elements are wasted and spread on the surrounding land. (See Appendix VIII GRO #2, Section 2 for blow-out prevention requirements).

(5) Rehabilitation

Rehabilitation activities vary with terrain and significance of damage.

(a) Off-road Vehicular Travel

Generally no rehabilitation is done because disturbance is temporary and, in most cases, heals itself in a short time.

(b) Road and Trail Construction

Generally no rehabilitation is done unless required for reduction of erosion hazard or elimination of access where none is wanted. If necessary, roads and trails can be scarified and reseeded.

(c) Drilling

The small drill holes for seismic and temperature gradient holes are usually rehabilitated by cleaning up any debris and smoothing the area with a bulldozer where needed. Mud pits are filled and leveled. Exploratory wells are handled the same except if they are successful a pressure control valve would be left on top of the well. Revegetation would be done in a manner approved by the Supervisor and the surface management agency.

b. Development

The development phase of geothermal resource operations would extend over a number of years. Different activities which take place during this phase include road construction, development well drilling and testing, geothermal pipeline construction, generating plant construction, transmission line construction and rehabilitation.

(1) Road Construction

During development, roads to drill sites, power plants and along transmission lines may be constructed. Roads to producing wells and power plants will be permanent and

probably surfaced. Temporary roads to drill sites and for construction of power lines are generally built to a low standard.

(2) Development Well Drilling and Testing

Development well drilling is similar to exploratory wells in impact on the environment. Drill rig sizes and drill pad requirements are similar to an exploration well. Generally 16 to 20 producing wells are used per power plant and, to prevent steam power loss, wells are generally located within one-half mile of the power plant. At the Geyers, a 40 acre well spacing is used.

A well in a potential geothermal resource zone must be production tested to clean the well out, determine flow rate, pressures, composition and temperature of fluids. At this time the amount of possible toxic substances is also measured so as to establish procedures to assure compliance with environmental and public health and safety requirements. When present in excessive amounts, some of these gasses and vapors are toxic:

GAS	TOXICITY LEVELS
Ammonia	50 ppm
Boric acid	None established
Carbon dioxide	5,000 ppm
Carbon monoxide	100 ppm
Hydrogen sulfide	20 ppm
Mercury	12.2 ppb
Methane	10,00 ppm

This testing requires venting the well to the atmosphere with accompanying vapor release and noise. The wells are generally muffled to bring noise levels within safety limits and the water is generally directed into a holding pond. This testing takes place throughout the life of a field as new wells are drilled and brought into production.

(3) Geothermal Pipeline Construction

Pipelines 10 to 30 inches in diameter are used to transmit steam from the production wells to the power plants. The pipes are typically insulated with fiberglass or asbestos to minimize heat loss. Expansion loops are placed at frequent intervals either horizontally or vertically because of pronounced thermal expansion and contraction of the pipeline during operation.

These pipelines are constructed above ground because of the thermal expansion problem and to aid in maintenance and detection of leaks. The lines form a radiating pattern, connecting wells with the power plant. They may be painted to blend with the surroundings.

(4) Generating Plant Construction

Generating plants are centrally located to minimize the length of the steam lines. The largest plants in current use consist of two 55 MW generators housed together. Power plant spacing is about one plant per 640 acres.

At the Geysers, the average 110 MW plant building is about 100 x 200 feet and three stories high. The adjacent cooling towers are about a third larger than the generating plant building. The entire generating plant-cooling tower complex occupies an area of about five acres.

(5) Transmission Line Construction

Power generated by the plants is transmitted via conventional power lines to the area of use. The size and location of the lines is dependent upon the power output and destination.

(6) Rehabilitation

Rehabilitation is possible on disturbed areas not needed for continued production. The amount of rehabilitation depends on terrain, significance of damage and a determination of the desirability of rehabilitation.

(a) Road Construction

Temporary roads can be scarified and revegetated.

(b) Drill sites

After completion, an area approximately 30 x 30 feet around the well will be needed for operation. The mud pit and other surrounding area can be graded and revegetated if determined to be desirable.

(c) Plant Construction

The area surrounding the generating plant can be rehabilitated and revegetated if determined to be desirable. Buildings can be painted to blend with the surroundings.

(d) Geothermal Pipelines

The pipeline may be painted to blend with the surroundings and areas not needed for access may be revegetated.

(e) Transmission Lines

The powerline route can be rehabilitated and revegetated with only necessary maintenance roads retained.

c. Operation

The operation phase begins with commercial power production. At the same time exploration and development are taking place in other parts of the geothermal field. Additional wells are needed to both enlarge the field and to replace wells that have become inoperative. If waste water must be reinjected, injection wells may be drilled.

The operation phase may be divided into the following discrete operations.

(1) New Drill Sites

Additional wells are drilled to place new portions of the field in production or to replace old wells that have become inoperative. The technique and effect of these wells would be the same as for development wells.

(2) Maintenance

Repair, maintenance and monitoring of an operating field requires the periodic use of access roads to service the equipment. Existing wells require repair work, the amount depending on the severity of scaling and corrosion.

(3) Waste Disposal

Waste disposal includes human generated, such as sewage and solid wastes, and geothermal wastes. Sanitary facilities for workers are provided and solid wastes are either disposed of in a dump at the site or hauled to the nearest established dump site.

Excess geothermal fluids is the most significant waste problem. In vapor dominated systems, as at the Geysers, about 75-80% of the water from the spent steam is consumed in the cooling towers, leaving 20-25% to be disposed of. In water dominated systems, such as Cerro Prieto, the reverse is true with 80% or more of the total well production requiring disposal. Three different disposal techniques are possible depending on the fluid characteristics. These are:

(a) Evaporation Ponds

Large holding ponds are constructed which may provide new aquatic habitat or be toxic so that special measures may be required to protect ground water supplies and animals.

(b) Natural Drainage System

The water may be discharged into existing drainage if its quality is high enough.

(c) Re-injection

Excess water is re-injected into nonproductive zones of the geothermal field. Use of this method depends on fluid characteristics and geologic characteristics of the field.

(4) Production

During production a geothermal field requires 2-5 people per plant to inspect, adjust and service wells. One drill rig necessary to service producing

wells and one or two drill rigs are needed to drill exploration or production wells. Rehabilitation is a gradual process throughout the life of a field. Areas in which work is completed and equipment removed are rehabilitated even though operations are continuing in other parts of the field.

d. Close-Out

This phase takes place after the geothermal resource has been depleted to the point that it is no longer economic to operate. The power plants, steam pipelines nad power transmission lines would be removed. The wells would be capped and landscaping and revegetation would be done where possible. The site could be returned to some semblance of its original condition and use.

5. Environmental Controls on Geothermal Exploration and Developments

Geothermal exploration and development is subject to a wide variety of environmental controls under the authorities of two main agencies, the U. S. Geological Survey and the Bureau of Land Management. For all actions up to issuance of a lease, the BLM is the responsible agency. The USGS is the responsible agency for all operational activities undertaken after a lease has been issued. The regulations of USGS and BLM detail the environmental controls (GS-30CFR270, BLM-43CFR-3200) and the agencies consult each other throughout the leasing program pursuant to Secretarial Order No. 2948 and an implementing cooperative agreement.

For this discussion the environmental controls will be divided into three sections based on when, during geothermal resource development they are instituted:

a. Controls not related to leasing,
b. Upon application for a geothermal lease,
c. After lease issued.

a. Controls Not Related to Leasing

If an operator wants to explore on unleased public land or on lands already leased to another party, they must apply with the BLM on a form called the "Notice of Intent to Conduct Geothermal Resource Exploration Operations" (Form 3200-9). This form must be filed with BLM District offices for any exploration activities

(other than casual use) which are not connected with a lease. This form contains a list of 21 general terms and conditions which the applicant must agree to abide by during any operations on the land. Also on this form is item #22 - Special Stipulations. These special stipulations, which can be added to the form, generally relate to specific conditions such as restrictions on surface occupancy of an area and restrictions on the time of year when operations will be permitted. The BLM must act upon such applications within 30 days of their receipt including preparing an environmental analysis. (See Appendix VI Form 3200-9).

Also, anytime prior to or after leasing, the Geological Survey can issue what are called GRO Orders - for Geothermal Resources Operational Orders. These set forth the requirements and procedures to be followed by an operator. (Appendix VIII).

b. Upon Application for A Geothermal Lease

The BLM is responsible for preparation of a pre-lease Environmental Analysis (EAR) or an Environmental Statement (EIS).

Within the BLM the Environmental Analysis is prepared for these reasons:

1. To provide a systematic and analytical process to improve the quality of BLM actions by identifying the anticipated environmental impacts of proposed actions and identifying ways of modifying those actions to minimize adverse environmental impacts and to enhance beneficial impacts.

2. To provide a background upon which a decision can be made relative to whether or not an EIS should be prepared.

3. To provide one of the documents upon which a manager can draw in making a decision to lease or not to lease. If the decision is to lease, the environmental analysis can provide a base for special environmental stipulations to include in the lease.

Therefore, the Environmental Analysis, which is recorded and documented in the EA Record format, is prepared for all BLM activities. The EAR allows BLM to identify environmental problem areas and if leasing is to be allowed, to develop special stipulations to prevent or mitigate any environmental damage.

If the Responsible Official determines that leasing "may have a significant impact on the quality of the human environment" then an Environmental Impact Statement will be prepared.

If the decision is made to lease, the "Geothermal Resources Lease" (Form 3200-21), would be prepared. This lease form requires the lessee to abide by 43 CFR part 3200 which are based on the Geothermal Steam Act of 1970. There are several sections on the form particularly related to environmental protection (See Appendix VII Form 3200-21).

Prior to issuance of a lease, the applicant must file a proposed plan presenting his proposed methods for diligent exploration. Included are proposed environmental protection measures. This plan helps alert BLM to any special stipulations which might need to be included in a lease.

Also, prior to issuance of a lease, special stipulations formed cooperatively with the U. S. Geological Survey can be added to the lease form - as was also true to the "Notice of Intent..." (which is not connected with a lease.) These special stipulations generally relate to specific conditions such as restrictions on surface occupancy of an area and restrictions on the time of year when operations will be permitted.

c. After Lease Issued

The lessee cannot conduct any operations on the land without submitting and obtaining approval of a Plan of Operation. Both the USGS and BLM must approve this plan. The plans generally are incremental with new phases of operation requiring a new plan of operation and again approval of the plan. The plan provides the detailed information on operations, location and methods that allows the development of specific, enforceable stipulations tailored to the plan. Special stipulations such as for erosion control, road and drill site locations and standards, surface facilities, restoration requirements, etc. may be developed when the plan of operation is being reviewed.

The USGS prepares an environmental analysis for all proposed exploratory wells with input from BLM. At BLM's request the USGS holds a joint field inspection with BLM and the applicant for proposed wells. BLM can prepare an Environmental analysis of any proposed well site to complete its records.

II. DESCRIPTION OF EXISTING ENVIRONMENT

A. Non-Living Components

1. Air

a. Air Movement Patterns

Air movement here is generally from west to east. Winter brings cold air from the northwest and summer breezes are usually from the southwest. Although strong winds may occur at any time they are more common from March to June. Peak wind velocities on the high desert can top 40 MPH and average about 12 MPH. Air movement in areas of broken topography is often gusty and sometimes triggers severe convection storms. Inversion conditions exist very infrequently.

b. Temperature

This is a land of short, warm summers and cool winters. Air temperatures can go as high as 110 degrees Fahrenheit in summer and plummet to minus 40 degrees Fahrenheit in winter. The number of frost free days become strikingly less with increases in altitude. Although frost can occur at any time, the average number of days between the last 28 degree Fahrenheit temperature in the spring to the first 28 degree Fahrenheit in the fall is 104, 86, and 32 days for the Prineville, Barnes, and Brothers weather stations respectively. See Appendix I for elevations and average monthly temperatures of the three weather stations previously mentioned. These time periods and temperatures are generally representative of those found at similar elevations within the lease area.

c. Particulate Matter

Although there has been no quantitative sampling done in the area, it is believed that particulate content is generally below secondary ambient air quality standards. These standards are possibly exceeded during periods of heavy winds in dry weather and/or during infrequent inversions.

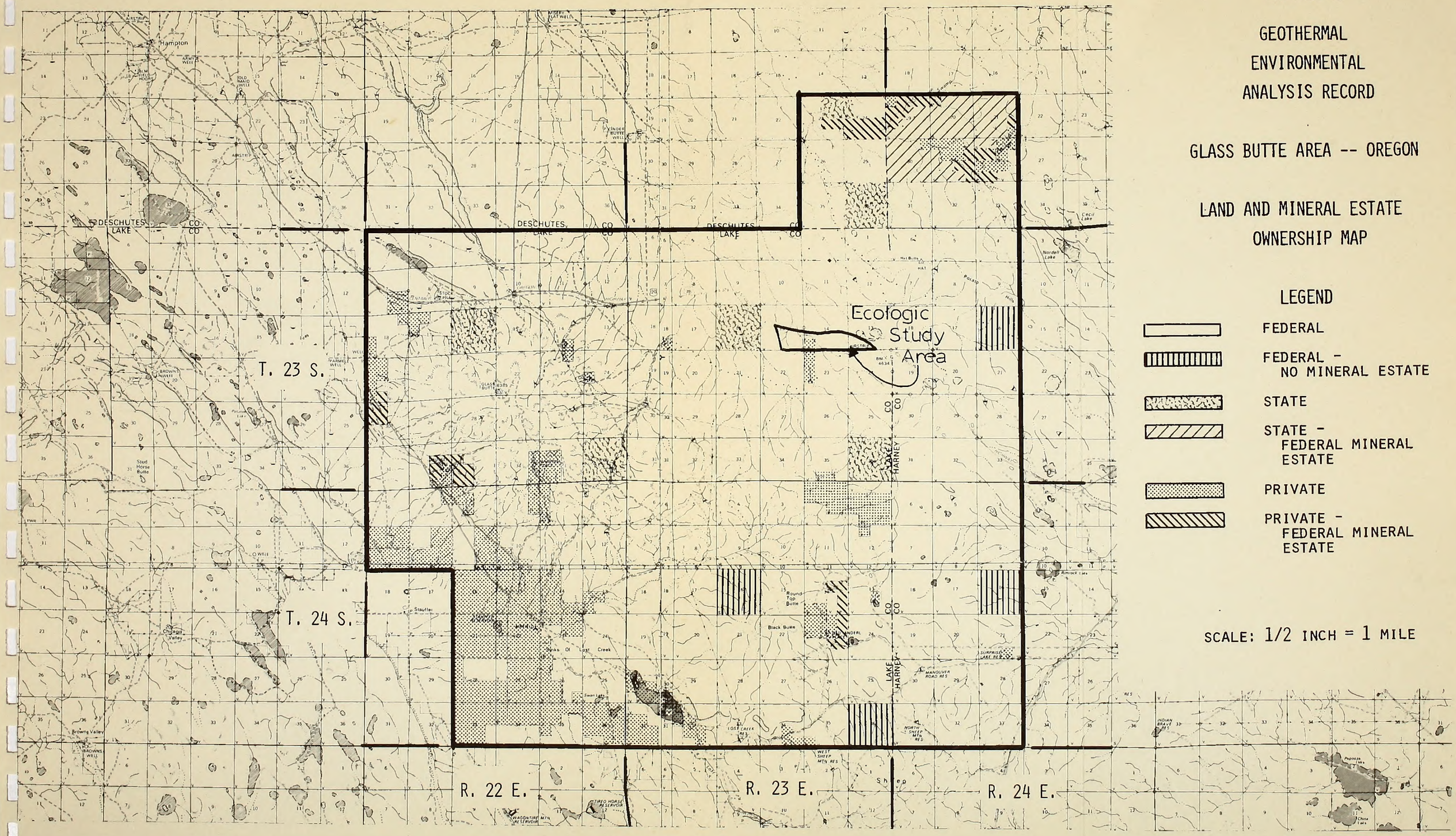
The occurrence of particulate matter is primarily seasonal. The warm, dry summers and relatively heavy winds of late spring and early summer contribute heavily

MAP No. 1

GEOTHERMAL ENVIRONMENTAL ANALYSIS RECORD

GLASS BUTTE AREA -- OREGON

LAND AND MINERAL ESTATE OWNERSHIP MAP



LEGEND

- FEDERAL
- FEDERAL - NO MINERAL ESTATE
- STATE
- STATE - FEDERAL MINERAL ESTATE
- PRIVATE
- PRIVATE - FEDERAL MINERAL ESTATE

SCALE: 1/2 INCH = 1 MILE

to an assumed low particulate total. Summer vehicular traffic normally has a following of particulates. Occasional smoke from controlled burning outside the area and from wildfires both outside and within the area usually occur in late summer and early fall.

The proposed lease area falls within the Central Oregon Intrastate Air Quality Control Region (Region 190). Air sampling stations for this region are at The Dalles. Bend and Klamath Falls. The Klamath Falls station maintains the only microscopic sampling device. It is believed that at least part of the information provided by this device can be applied to the other stations, i.e. % mineral material. Information provided by these stations is shown, along with Oregon Ambient Air Standards, in Appendix I.

d. Noxious

There has been no quantification of noxious gases in the proposed lease area. The nearest monitoring device for gases is located at Klamath Falls and it is limited to SO^2. Information provided by this device is included in Appendix I.

Minute concentrations of noxious gases (carbon monixide, hydrocarbons, nitrogen oxides, and sulfur oxides) are produced by infrequent fires occurring in or near the area, and by internal combustion engines which power automobiles and machinery. However, the sparse population and relatively light vehicular traffic common to the area is conducive to an uncontaminated atmosphere. There is no natural fumarole activity or other natural sources of air pollution in the area.

e. Radiological Contaminants

There have been no unnatural sources of radiological contamination identified in the area.

f. Non Ionizing Radiation

The only identified source of non ionizing radiation is a high voltage power line passing through the extreme north-east corner of the area.

2. Land

a. Soil Associations

The soil associations of the Glass Buttes area are of three basic types: (1) old terraces and tablelands farmed in materials weathered from basalt, tuff, and breccia, (2) alluvial material and sedimentary soils on nearly level basin terraces, and (3) rockland.

Old terraces and tablelands are dominant covering 89% of the land surface. The dominant soils are the shallow to hardpan (10 to 20 inches) Olson and Floke soil series with subangular blocky strucutre. The Floke soils have a heavy clay and horizon and producer low sagebrush. Water supplying capacity is 6 to 8 inches annually. The Olson soils produce Big sagebrush and have a water supplying capacity of about 3 to 9 inches annually. Detail soil interpretations for the Olson and Floke soils are in Appendix II.

Alluvial and sedimentary soils occupy 10% of the land surface. These soils are generally deep, well drained, bottomlands. Water supplying capacity is 10 to 12 inches annually.

Rockland or outcrop occupies about 1% of the area and consist mainly of rhyolite, dacite and basalt.

b. Soil Nutrient and Pollution Properties

No data is available at this time.

c. Erosion

Natural wind and water erosion is moderate on most of the undisturbed soils. Rill and sheet erosion is most prevalent on the old lake beds. Natural erosion on the valley lands is insignificant because of the level terrain.

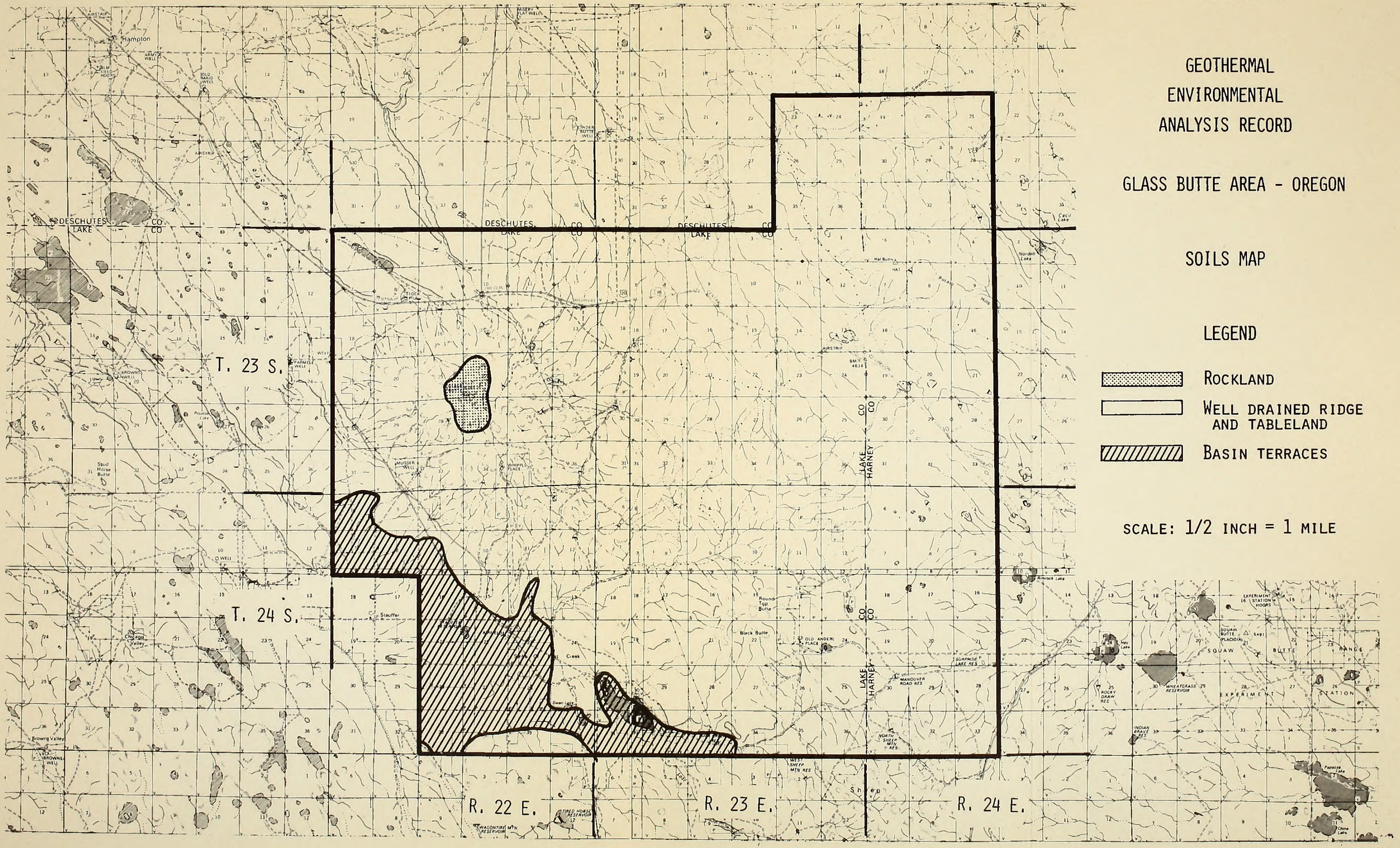
Where soil disturbance has occurred and the vegetation removed because of mining or other activities, erosion has become critical. Since these soils are shallow and in many cases have only a few inches of an "A" horizon, the top and sub soils are eroded by rill or sheet erosion very quickly thereby making natural revegetation of these areas difficult. There are

MAP No. 2

GEOTHERMAL ENVIRONMENTAL ANALYSIS RECORD

GLASS BUTTE AREA - OREGON

SOILS MAP



LEGEND

- Rockland
- Well drained ridge and tableland
- Basin terraces

SCALE: 1/2 INCH = 1 MILE

many soil scars left by cinnabar mining in the area that have not revegetated naturally and are subject to critical wind and water erosion.

d. Geology

The Glass Butte area is located in the High Lava Plains physiographic province, a broad upland underlain by volcanic and sedimentary rocks of middle to upper Cenozoic age. The region has been mapped by Walker et al. (1967) and Greene et al(1972). This mapping shows the Glass Butte area to be a silicic domal complex consisting of rocks of dacitic to rhyolitic composition surrounded by tuffaceous sedimentary rocks and basalt and andesite flows. The sedimentary rocks are fluviatile and lacustrine tuffaceous sandstones, siltstones, and claystones. Some of these sedimentary rocks are thin intercalations between lava flows and others are thicker sequences where lakes were formed. Walker (1974) obtained a potassium-argon age date of 4.9±0.3 million years from obsidian of the silicic complex. A geologic map and rock unit descriptions are included to provide greater detail of the stratigraphy of the EAR area.

Structurally, the Glass Butte area is dominated by a major northwest-trending lineament informally termed the Brothers fault zone. The brothers fault zone, consisting of parallel and partially en echelon high angle normal faults, extends at least from the eastern margin of the Harney Basin on the west end to the Cascade Range on the east (Walker, 1974). Walker (1969) states that these faults may "denote only adjustment of surface and near surface volcanic and tuffaceous sedimentary rocks," and may only be the "...surface manifestations of deformation on a large, deeply buried structure, the exact nature of which is not known."

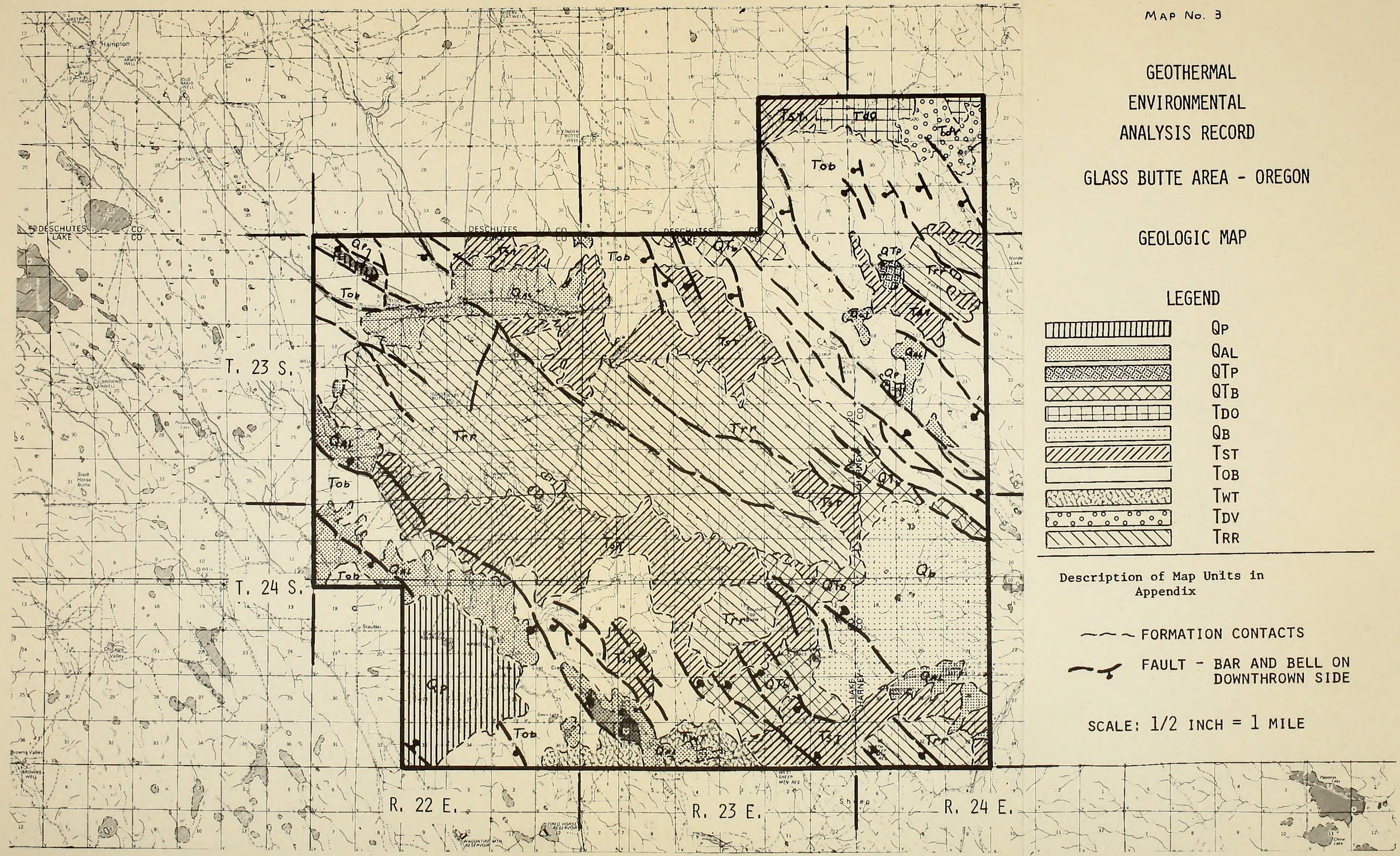
The principal economic mineralization in the area is mercury. A cinnabar mine is located in Section 34, T. 23S., R. 23 E., W. M. Mining ceased in 1968 when available economic ore was depleted. Approximately 100 flasks of mercury was produced. Two other prospects with several claims each are located in the area, being in Section 3, T.24S., R. 23E., and Section 34, T. 23 S., R. 22E., W. M. The mercury is located in brecciated fault zones with a silica-cinnabar (opalite) mixture occurring as fracture filling (Brooks, 1963).

The obsidian of Glass Buttes is nationally known in the rockhound fraternity. The majority of the area containing obsidian has been segregated from mineral entry for obsidian and chalcedony minerals. Limited mining of obsidian takes place on claims located prior to the segregation. The Oregon State Highway Department has several material sites within the EAR area which are used for both storage of road rock and as material source sites. These are located adjacent to U. S. Highway 20. The Glass Butte area has abundant material which is suitable for crushable rock to be used on road surfacing and maintenance.

Oil and gas exploration in Central Oregon has been sporadic with no exploratory drilling within the EAR area. The closest drilling was by Standard Oil of California in 1955 in T. 20S., R. 20E. This well was drilled to 7594 feet with some traces of oil in core samples (Stewart and Newton, 1965). Since geothermal drilling would involve deep test holes, the stratigraphic and structural information gained could encourage renewed oil and gas exploration.

The geothermal potential of the Glass Butte area is poorly defined and the nature of the heat source and heat transfer mechanism are not defined. Based on estimates of age, magma volume and cooling rates, Smith and Shaw (1975) concluded that the area possibly had residual magmatic heat and estimated that there was little geothermal potential. However, geothermal gradient measurements in Section 18, T. 23S., R. 23 E. and Section 12, T. 24S., R. 22E. have shown higher than normal gradients of 144° and 122° C/km respectively (Bowen, et al. 1976). This is in addition to a water well in Section 34, T.23S., R. 23 E. with a measured gradient of 190° C/km. There are no active hot springs or fumeroles in or near the EAR area but Glass Butte has had hydrothermal activity as shown by the previously mentioned rock alteration and mercury mineralization.

Geologic hazards in the EAR area should be minimal. Although faults are found, and they should be considered to be capable of movement, the entire region has a very low seismic activity level (Couch and Lowell, 1971). Mass Movements, including landslides, are very rare in this area.



MAP No. 3

GEOTHERMAL ENVIRONMENTAL ANALYSIS RECORD

GLASS BUTTE AREA - OREGON

GEOLOGIC MAP

APPENDIX TO GEOLOGIC MAP

DESCRIPTION OF MAP UNITS:

From:

Geologic Map of the Burns Quadrangle, Oregon
USGS Map I-680

Qp - Playa deposits - Clay, silt, sand, and some evaporite deposits.

Qal - Alluvium - Sand, gravel, and silt.

Qb - Basalt - Medium gray, micrograined, containing plagioclase, olivine, and augite grains. Several thin flows, tumuli at surface.

QTb - Basalt - Mostly olivine-bearing basalt; commonly vesicular. In places consists of several thin flows separated by thin layers of sedimentary rocks.

QTp - Pyroclastic rocks of cinder cores - Subaerial deposits of unconsolidated reddish fine to coarse scoriaceous basaltic ejecta.

Tdo - Welded tuff of Double O Ranch - Pumiceous welded ash-flow tuff exposed in northeast corner of analysis area. Age, about 6 m. y.

Tst - Tuffaceous sedimentary rocks - Well to semi-consolidated tuffaceous sedimentary rocks and tuffs, typically poorly stratified; commonly consists of poorly sorted mixture of pumice, scoria, other rock fragments, in clay matrix. Mostly lacustrine, in part fluviatile in part of air-fall origin. Age, early and middle pliocene.

Tob - Basalt - Olivine-bearing basalt, dense dark-gray basalt, and some andesite not assigned to a specific unit. Locally includes thin interbeds of tuffaceous sediments.

Twt - Welded tuff - Welded ash-flow tuffs not assigned to a specific unit; exposed in southern portion of analysis area.

Tdv - Welded tuff of Devine Canyon - Crystal-rich welded ash flow tuff exposed in extreme northeast corner of analysis area.

Trr - Rhyolite and Rhyodacite - Variously light-colored, commonly flow banded rhyolite and rhyodacite. Mostly porphyritic with phenocrysts of plagioclase, alkali feldspar, and quartz; contains masses of obsidian or perlitic glass and, locally, masses of opalite. Occurs as exogenous domes and related flows and plugs. Age, late Miocene and Pliocene.

e. Land Use Compatibility

Rockhounding, hunting, roadways, offroad vehicles, sightseeing, livestock grazing, wildlife habitat, watershed management, and mining are current uses of the land. Mining is not considered totally compatible with other land uses since it restricts any other use in or directly around the mining area. Mining also is responsible for much of the road construction and the loss of aesthetic appearance that is needed for sightseeing.

Primitive values are low since U. S. Highway 20 dissects the area, plus innumerable roads and trails. Mining and rockhounding are all influences put on the land by man that cannot be avoided.

f. Land Use Suitability

All of the soil on the land is best suited for grazing, wildlife habitat, and watershed management. Most of these soils are poorly suited for sources of road fill, top soil, or gravel. Cut slopes are hazardous due to possible sliding, but the soils are moderate for foundation use. The upland plateaus and terraces are poorly suited for reseeding or artifical revegetation. The Glass Buttes area is suitable for cinnabar mining or extensive excavations of obsidian, both of which remove the vegetation and top soil.

3. Water

a. Hydrologic Cycle

Annual precipitation in the Glass Butte area is 9-12 inches. Eighty percent is received between October and May, primarily in the form of snow. Minor amounts of precipitation occur during the summer from periodic thunderstorms. The evaporation rate is 45+ inches for the period June 1 to October 31, according to the Summer Lake weather station. The area lies within the rain shadow created by the Cascade Mountains.

TABLE 2

AVERAGE MONTHLY AND ANNUAL PRECIPITATION (INCHES)
1965-1970
HAMPTON STATION

JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
1.37	0.38	0.38	0.40	0.71	1.56	0.36	0.70	0.35	0.59	1.22	0.98	9.00

BASED ON PARTIAL DATA DUE TO INCOMPLETE RECORDING

b. Sediment Load

There are no permanent streams to continuously carry a sediment load. Stream sediment load movement is intermittent depending on precipitation.

c. Dissolved Solids

No recorded analyses of ground water from the area is known. Wells around the area are used for livestock watering and are presumably of relatively high quality. The hydrology of the Glass Butte area is poorly known. One recorded source of information is the Columbia-North Pacific Region Comprehensive Framework Study*. This source offers a narrative and graphic descriptions of the various aquifer units within the two sub-regions in the planning unit. Also available is "Basic Groundwater Data in Lake County, Oregon," a USGS open-file report by F. D. Trauger, 1950.

B. Living Components

1. Plants (Aquatic)

Aquatic plants occur in several springs and reservoirs which have year long water. Plant populations are affected by seasonal fluctuation in water levels and precipitation. Aquatic plants common in the area include Richardson's pondweed, water buttercup, watercress, mosses, rushes and phytoplankton.

2. Plants (Terrestrial)

Vegetation of the planning unit is typical of the

Northern Great Basin type, consisting of an overstory of big sagebrush and an understory of various species of perennial forbs. Of the bunchgrasses, bluebunch wheatgrass, Idaho fescue, needlegrass, and squirreltail predominates. Rabbitbrush occurs in varying amounts throughout the unit, but predominates only on disturbed sites. Western juniper occurs in the higher elevations and along the fringes of lava rims. Bitterbrush, mountain mahogany and gooseberry occur in a few areas, but are generally found at higher elevations. A number of areas within the unit have had extensive vegetation rehabilitation. Portions of these areas were seeded to crested wheatgrass.

An area in Sections 13, 14 and 15 T. 23 S., R. 23 E., South of U. S. Highway 20 has been identified as an ecologic study area in the sagebrush vegetation type. This area is unusual in that it has not been grazed since 1951. (See Land Status Map).

Some noxious weeds notably larkspur and death camas, occur within the unit. Larkspur has caused some loss of livestock in past years.

The major list of plant species can be found in Appendix III.

a. Lichens and Mosses

Lichens and mosses occur throughout the area on rocks, and in springs and reservoirs. They are more abundant in areas where moisture and temperature are adequate.

b. Grasses

See Appendix III.

c. Forbs

See Appendix III.

d. Shrubs

See Appendix III.

e. Conifers

Western Juniper

f. Broadleaf Trees

Aspen

3. Animals (Aquatic)

a. Mammals

Sources of adequate water are the limiting factors on aquatic animal populations. Seasonal and yearly precipitation fluctuations also have a great effect upon the amount of water available.

There are numerous springs and a few reservoirs which have year long water and could support aquatic life.

The raccoon is dependent upon water and may be found in the proposed area during the year.

b. Birds

Aquatic bird use in the area is limited to summer residents, visitors and birds migrating through the area. These birds depend on the area for food, nesting and resting areas. Common aquatic birds found in the area include mallard ducks, Canada geese, rails, coots, avocets and occasionally a gull. (See Appendix III)

c. Amphibians and Reptiles

The northern long-toed Salamander is dependent upon water during its breeding season and early development stage. The same also applies for the frogs which inhabit the area. (See Appendix III).

d. Fish

There are no known fish in the proposed Geothermal Lease Area.

e. Invertebrates

Aquatic insects are found on the reservoirs and in springs. Common insects include water boatmen, striders, creepers and back swimmers.

Population dynamics are not known at this time.

f. Zooplankton

Zooplankton are present in the water sources but no study or record has been made of kinds and population levels.

4. Animals (Terrestrial)

a. Mammals

Mule deer are the most common big game mammal found in the area. The Oregon Wildlife Commission estimates that approximately 100 deer summer in the area and 300 winter in the area. The deer are found over the entire area with summer use being at the higher elevations in the juniper, big sagebrush vegetative sites. Winter use is at a lower elevation in the big sagebrush, low sagebrush vegetative types.

Some antelope summer north of Glass Butte and winter south of Glass Buttes. The main vegetative types used by antelope are open low sagebrush flats and revegetated areas.

Small mammals are found over the entire area.

Approximately 4,500 AUMs of livestock use occurs in the area by cattle. There is also some use by horses on private lands. There are no known wildhorses in the area. The season of use by domestic stock is spring, summer and fall.

b. Birds

The proposed lease area lies within the Pacific Flyway which makes the area accessible to over 100 species of birds. Most are visitors to the area or only part year residents. The Peregrine Falcon, on both the national and state endangered species lists, has been sighted near the G. I. Ranch headquarters. A sage grouse strutting ground has been identified in Section 27, T. 23 S., R. 23 E. Sage grouse are currently on the state "status undetermined list" because of a constant long-term population decline. An eagle winter concentration area has been identified along U. S. Highway 20 near the West boundary of the area. No raptor nests or other critical habitat areas have been identified in the proposed lease area. See Appendix III for a detailed listing of birds, status and occurrence

c. Reptiles

There are several terrestrial reptiles which could be found in the proposed lease area. Common among these are the spadefoot toad, sagebrush lizard, desert horned lizard, skinks, garter snakes, gopher snakes and western rattlesnake. The only venomous reptile is the rattlesnake.

The northern long-toed salamander is considered in both aquatic and terrestrial animals because of its life requirements. (See Appendix III.)

d. Invertebrates (Insects)

The significance and status of most invertebrates (insects) is not known for the proposed lease area. Groups of insects occurring in varying abundance include the following:

Spiders

A variety of spiders are found in the area.

Woodticks

Aphids

Lice

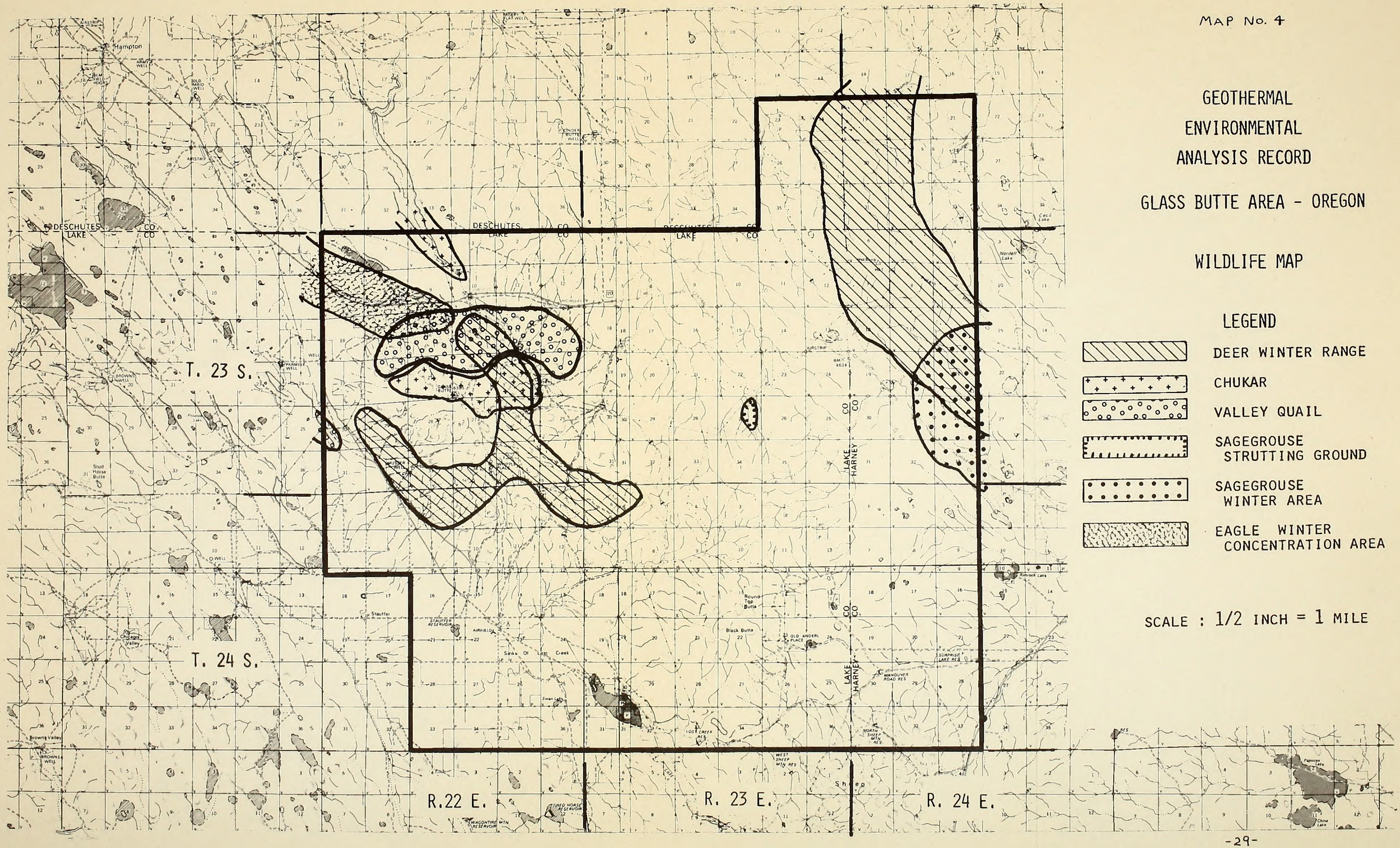
Generally associated with animals and birds in the

MAP No. 4

GEOTHERMAL ENVIRONMENTAL ANALYSIS RECORD

GLASS BUTTE AREA - OREGON

WILDLIFE MAP



LEGEND

- DEER WINTER RANGE
- CHUKAR
- VALLEY QUAIL
- SAGEGROUSE STRUTTING GROUND
- SAGEGROUSE WINTER AREA
- EAGLE WINTER CONCENTRATION AREA

SCALE : 1/2 INCH = 1 MILE

area.

Ants

Stink beetles

Grasshoppers

Flies

These include deer flies, horse flies, bot flies, and house flies.

Sagebrush webworm

Tent Catepillar

Moths

Butterflies

Mosquitoes

The mosquitos and ticks are the most bothersome to man. Those plus flies and lice bother mammals and birds in the area.

e. Man

Activities involving man can be found over the entire proposed lease area. The activities include rockhounding, hunting, mining, mineral exploration, ranching and general sightseeing. Most activity takes place during the summer months.

Mineral activity is located south of Highway 20 and east of the main Glass Butte. Rockhounding for obsidian takes place in the same general area.

The only inhabitance presently occupied within the area is at the cinnabar mine in Section 27, T. 23 S., R. 23 E. Other buildings are present in the area but are not occupied.

Mineral activity and rockhounding has caused considerable ground disturbance in some areas. Some sites present hazards to man and animals.

C. Ecological Interrelationships

1. Succession

At the present time much of the proposed geothermal lease area is in a stable condition but is not producing vegetation at the maximum potential. It has become an ecosystem composed of less desirable dominant vegetative species.

Livestock grazing practices have been a major reason for the condition of the vegetative associations. Overgrazing in the past by cattle, sheep, horses, and big game during critical plant stages has killed some desirable shrubs such as bitterbrush and grasses such as bluebunch wheatgrass and Idaho fescue, have been replaced by sagebrush, juniper, etc. Some animals are dependent on these forage values. Habitat is critical to the survival of a species, i.e. big game winter ranges, fawning and calving ranges and nesting sites.

There are other factors besides grazing which have changed the ecology. Road building, hunting, wildfire, recreation use, rockhounding, mining and mineral exploration. Mining and exploration have had a great effect on a large acreage of the area. Many exploration pits and surface disturbance areas are located east of Glass Butte and northwest of Round Top Butte.

The hydrologic cycle is affected by these conditions because a less desirable vegetative composition or lack of vegetation is present which allows increased runoff and an increase in soil loss. The timing, quantity and quality of runoff have been affected. Poor watershed conditions cause increased sediment loads from sheet, rill, gully, and channel erosion. This in turn reduces the vegetation production potential by reducing soil fertility and the availability of suitable habitat for forage species.

The natural ecological trend is a slow movement towards a mature stand of dominant species. Many successions initiated by past improper land uses are reversible. The reversal of the pattern may require drastic action, particularly if time is important. Examples include chemical and/or mechanical vegetation conversion for wildlife, watershed or livestock. Man and his agents often caused the original change in the environment. He also offers the fastest, and in

many cases the only, method of further alteration. The desired successional change may be back to the original ecological community or to some new habitat.

2. Food Relationships

Food Relationships in the area are complex.

All plant eating animals, domestic and wild, require a variety of plant species to satisfy their needs for food. For example, mule deer require a variety of browse plants, with lesser amounts of herbaceous plants, to satisfy winter forage requirements. During the spring and summer, herbaceous plants become important forage suppliers. There are a few forage species that can serve as single-item diets and sustain mule deer for at least several weeks. Mule deer, as many other wild animals, need mixtures of several forages to maintain good condition, maximum survival and gain. The vegetation is a limitng factor for the continuance of the food chain and energy transfer.

Domestic livestock do not require the same variety in forage as the wildlife. They prefer variety but can survive some seasons very well on almost a strict grass diet. This characteristic can be used to good advantage in adjusting livestock use to areas with less conflict and high forage production potential.

Lichens and mosses may also supply food value to some organisms. This is particularly true at the early steps in the food chain.

The major animal organisms in food relationships include invertebrates (worms, insects, etc.), reptiles and amphibians, small mammals, and large mammals. Birds may be involved almost anywhere in the food chain, from the songbird eating an insect to a golden eagle or turkey vulture eating the flesh of the largest mammal. Nutrient cycling would be complete, except for those portions of the chain removed by man.

Water is a critical part of all the food relationships. The seasonal and geographic distribution of water supplies for livestock, wildlife, and plants often dictate the population and distribution of these communities. Water developments, such as spring improvement and reservoir construction, often enhance and expand habitat for many species. An improved spring may provide water critical to an intensive grazing

system; improve habitat for a wide range of wildlife species such as deer, upland birds, and songbirds, and improve watershed conditions by relieving pressures on existing water supplies. Natural water supplies may require supplementation, particularly in drought years, in order to sustain dependent populations. The water supply is often the limiting factor in the food chain.

3. Community Relationships

The primary ecological factors involving community relationships in the area revolve around food, water and cover requirements of the resident plant and animal populations. All of the actions, reactions and interaction among and between organisms of the site are based on these requirements.

Plants are dependent upon the soil for moisture, nutrients and physical support. The soil is dependent upon the plants for organic matter, stability from erosion and microbial activity. Some soils will support a particular type of vegetation, while others support a greater variety.

Examples of vegetation influences by soils are: low sage, black sage, stiff sage, silver sage, juniper, several desert shrubs, ricegrass and others.

The soil-animal relationship is important to both the animal species and the soil. The animals, insects, nematodes, and protozoa are important to the soil in that they start the conversion process of changing organic matter into minerals and nutrients, which in turn can be used by growing plants. Many insects and small animals are dependent upon the soil for cover and/or habitat in which to live.

Animals are dependent upon the plants. Inadequate cover and forage decrease the value of animal habitat. The increase of juniper has increased mule deer cover and decreased livestock forage production. The reduction of browse by wildfire and vegetative treatment has often reduced wildlife forage and cover but improved livestock forage and watershed conditions. On other areas overgrazing by domestic animals has allowed an increase in browse, and less desirable forbs with a corresponding decrease in palatable forbs and grasses. This may have improved wildlife habitat while the livestock conditions deteriorated.

D. Human Values

1. Landscape Character

The landscape within the proposed geothermal lease area is one of rolling hills dominated by Glass Butte and to a lesser degree Round Butte, the primary land forms in the area. Both of these Buttes were created by volcanic instrusions which may have furnished much of the material for the formation of the widely spread lava flows which form the surface of the area. These buttes have been deeply cut by erosion into the irregular formations which exist today.

These buttes provide variety and contrast to the relatively monotonous landscape which prevails in the High Lava Plains physiographic region between Bend and Burns. Glass Butte and Hampton Butte (which lies just outside the proposed geothermal lease area) provide relief and a change of scenery for the average of 770 vehicles which travel this portion of U. S. Highway 20 each day. Glass Butte lies immediately south of this primary east-west travel route and is highly visible from the highway. Aesthetics and disruptions of the natural character of the landscape are much more critical when they occur within the foreground middleground of this major travel route.

Lines are evident in the skyline of Glass and Round Buttes, roads, and because of the color contrasts, in the rock outcrops. In closer perspective lines are visible in individual rocks, trees and shrubs although subordinate to the skyline.

The buttes are fine textured as viewed from Highway 20 and rocks near the highway are more coarse.

The area has a very subtle and harmonious color scheme. Muted greens, grays, browns and buffs of the vegetative cover and exposed volcanic rock blend together with little contrast in color or texture. Seasonal changes in vegetative colors result from the scattered growth of browse species. In the fall and winter months the more bleak colors of gray and brown replace the green dominated landscape that exists during the late spring and early summer.

Man's mark has been left on the land through past grazing practices and range improvements. Many fences crisscross the area. Livestock trails and primitive roads have come into being and livestock (cows) graze throughout the area. While these improvements would detract from

a primitive environment they do not substantially effect the less pristine character of the Glass Butte area. The intensive settlement and grazing by the white man which began in the early 1900's was the first major intrusion on the pristine landscape. Since that time the less primitive character of the area, has for the most part remained static.

The landscape theme of the butte area which comprises the bulk of the proposed geothermal lease area is one of a vast open rocky landscape with rolling sagebrush covered hills surrounding the abrupt and rugged Glass Butte and Round Butte.

The greatest alteration of the landscape that has tended to change its character are the "pockmark" scars left by mercury mining on the hills in the southeast portion of the area. As late as 1957 significant amounts of cinnabar ore was extracted and processed on mining claims in the area. Exploration and extracting has resulted in much surface disturbance. There are also 2 main cinnabar pits which have left significant scars on the landscape. There is presently no extracting or processing occurring on any of the mercury mining claims in the area.

The presence of U. S. Highway 20, which passes through the northern portion of the unit, has a very significant impact on the character of the landscape. The highway itself detracts from the open space desert environment and has significantly altered the character of the area.

2. Accentuating Element

The high desert landscape is one of general uniformity almost to the point of being monotonous. The prominence of Glass Butte and nearby Hampton Butte rising approximately 1,700 feet above the surrounding terrain provides the only significant topographical accent to the desert landscape.

Vegetation and the other features of the landscape do little to increase or intensify the existing natural character.

The landscape of the Glass Butte area has been impacted in the past by the construction of a primtive road which ascends the east side of the Butte to gain access to a telephone microwave station. This station consists of a small concrete block building with a large antenna and three microwave reflectors. This construction work is not visible from US Highway 20, but is easily seen from anywhere in the east and southeast portion of the area.

The visual resource map (Map No. 5) was arrived at after evaluation of the scenic qualities of the area, the volume and visual sensitivity of the people normally viewing the area and how "visible" the area is from travel routes and other people concentration areas. The Visual Resource Management Class indicates the level or degree of visual impact which can be tolerated. It is expressed in various classes ranging from 1 through 5. The visual management objectives for these classes are as follows:

Class I: This class provides primarily for natural ecological changes only. It is applied to primitive areas, some natural areas, and other similar situations where management activities are to be restricted.

Class II. Changes in any of the basic elements (form, line, color or texture) caused by a management activity should not be evident in the characteristic landscape.

Class III. Changes in the basic elements, (form, line, color, texture) caused by a management activity may be evident in the characteristic landscape. However, the changes should remain subordinate to the visual strength of the existing character.

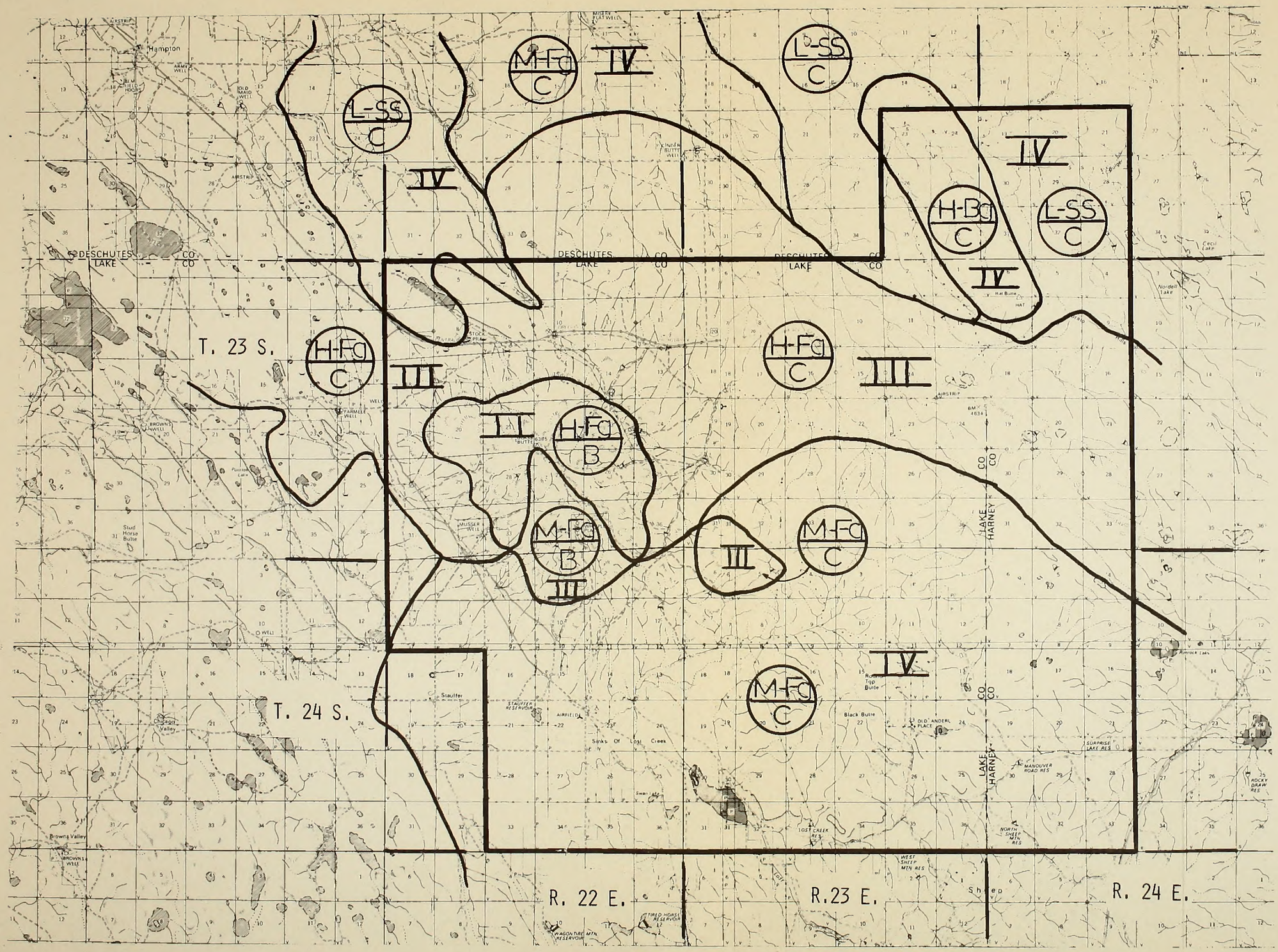
Class IV. Changes may subordinate the original composition and character but must reflect what could be a natural occurrence within the characteristic landscape.

Class V. Change is needed. This class applies to areas where the naturalistic character has been disturbed to a point where rehabilitation is needed to bring it back into character with the surrounding countryside. This class would apply to areas identified in the scenery evaluation where the quality class has been reduced because of unacceptable intrusions. It should be considered an interim short term classification until one of the other objectives can be reached through rehabilitation or enhancement. The desired visual quality objective should be identified.

A proposed surface disturbing project can then be analyzed for its usual impacts on the landscape in terms of form, line, color and texture and determine whether or not it will be an "eyesore".

3. Educational-Scientific

Before the coming of early settlers, the area was heavily used by early man as a source of material (obsidian) for his weapons and other tools. This locale seemed to be the stopping place for migrations from summer hunting grounds to



GEOTHERMAL

ENVIRONMENTAL ANALYSIS RECORD

GLASS BUTTE AREA - OREGON

VISUAL RESOURCES MAP

LEGEND

III — ROMAN NUMERIALS DENOTES SCENIC CLASSIFICATION AREAS

SCENERY VISUAL ZONE

Fg - Foreground
Mg - Middleground
Bg - Background
SS - Seldom Seen

SENSITIVITY

L - Low
M - Moderate
H - High

M-Fg / C

SCENERY QUALITY

A - High
B - Moderate
C - Low

SCALE: 1/2 INCH = 1 MILE

wintering areas to the south. Early Indians gathered obsidian and flaked points as is evidenced by scattered "chipping grounds" found in the area. Glass Butte's obsidian was taken and bartered throughout the northwest. No permanent structures or improvements left by early man are known to exist in the area, however, his influence and history is undoubtedly there. Many remnants of early cultures in the area have been destroyed by white man's settlement and development, however, other features such as burial grounds, and early tools exist in the area.

A systematic archeological survey was conducted during August, 1975, by the University of Oregon Department of Anthropology on 14% or approximately 12,000 acres of the proposed lease area. A total of 131 sites were discovered and recorded with another 640 sites estimated to exist within the lease area.

All of the sites which were discovered had one or more of the following characteristics: (1). Close association with an obsidian source. (2) Close association with a water source. (3) Had a good view of the surrounding terrain. Using these characteristics as guides, one could predict or expect to find archeological sites along intermittent streams or hills, adjacent to high quality obsidian outcrops, along margins of dry lakes, near springs and on top of fault scarp ridges and knolls. However, significant sites may occur almost anywhere within the lease area.

Archeological sites found in the lease area are primarily small campsites, knapping stations (chipping grounds), quarry sites and rockshelters generally found in the areas delineated on the included map.

The first recorded impact on the area by white man was in 1845 when the lost Meeks Wagon Train passed through the area.

Over 200 wagons wandered aimlessly through this region in an attempt to find a better emigration route from the east into the northwest. There are no marks on the ground today which can be authenticated as being remnants of the lost wagon train, but the hardships and the privations they sustained in the area are well documented. Historians place their suffering secondly to the famous Donner party which was stranded in the Sierra Mountains as they proceeded to California.

The lost Meeks Wagon Train also is credited with discovering the Blue Bucket Gold Mine which was

found and then lost because the travelers could not later retrace their steps to their point of discovery. Some historians place this lost gold mine in the vicintiy of Hampton and Glass Buttes.

The early 1900's marked the most significant period of growth and development in the high desert. Land developers envisioned diverting water from Newberry Crater and using it to irrigate the high desert for wheat production. This resulted in many homesteads being taken up between Horse Ridge and Wagontire Mt. The towns of Stauffer, Rolyat, Brothers, Hampton, Fife and others came into existence and began to prosper. A few years after the initial settlement came it was realized that agricultural schemes in this area were not feasible. The area died as quickly as it had flourished with only the small settlements of Hampton and Brothers surviving. They were located adjacent to the Bend-Burns Highway which had been constructed during that period of settlement. Travel on that road which is now US Highway 20 still accounts for much of the livelihood of these small communities.

Hampton, located adjacent to U. S. Highway 20, 70 miles east of Bend and 60 miles west of Burns, consists of a gas station-restaurant with limited facilities for lodging. A BLM field station which is only occupied periodically is the only other facility in "this wide spot in the road." Any public services beyond the emergency type must be obtained in Bend or Burns. Bend is a larger and more diversified population center than Burns, however, both provide adequate services and facilities for transient as well as resident populations.

The same obsidian deposits used by early man for the flaking of points now attract nearly 5000 rockhounds annually in search of the glass material. Many expert rockhounds consider the Glass Butte obsidian deposits the best in the nation because of the quality, quantity and variety of the material found in the area.

The Glass Butte area also receives moderate hunting pressure for mule deer and antelope, however, this use does not equal the popularity of rockhounding.

4. Cultural Values

There are no known values associated with the Glass Butte area as it relates to the integrity or identity of any contemporary culture or group of people.

5. Social Welfare

The only direct flow of goods and services within the proposed lease area is from income and expenditures by the two full time residents living within the area. A semi-retired miner and his wife live on one of the cinnabar claims. Their income is derived from outside social security revenues and from small sales of obsidian to the public. This income enables them to live at a level of prosperity that they feel is sufficient.

Other incomes are derived from this area from people living outside the proposed lease area. This revenue is primarily a result of livestock production and the extracting of obsidian for commercial resale. Though this revenue is generated in the area it is disposed of in non-local markets.

The potential for economic growth and development in this area seems unlikely, except for the unknown potential of geothermal steam exploration and development. It's impact could be minimal or it could be very extensive, by creating support communities to maintain and operate large scale power generating facilities.

6. Attitudes and Expectations

Primary concerns regarding geothermal exploration and development in Central Oregon are concentrated in the Newberry Crater, an outstanding scenic and recreational area located approximately 50 miles west of Glass BUtte.

Public sentiment does not seem to be against geothermal development as long as other resource values are given equal consideration. Various individuals and groups were contacted in an attempt to gain public response to geothermal development potential. The names of the individuals contacted and their response to our inquiries are contained in Appendix IX of this analysis.

7. Local Regulatory Structures

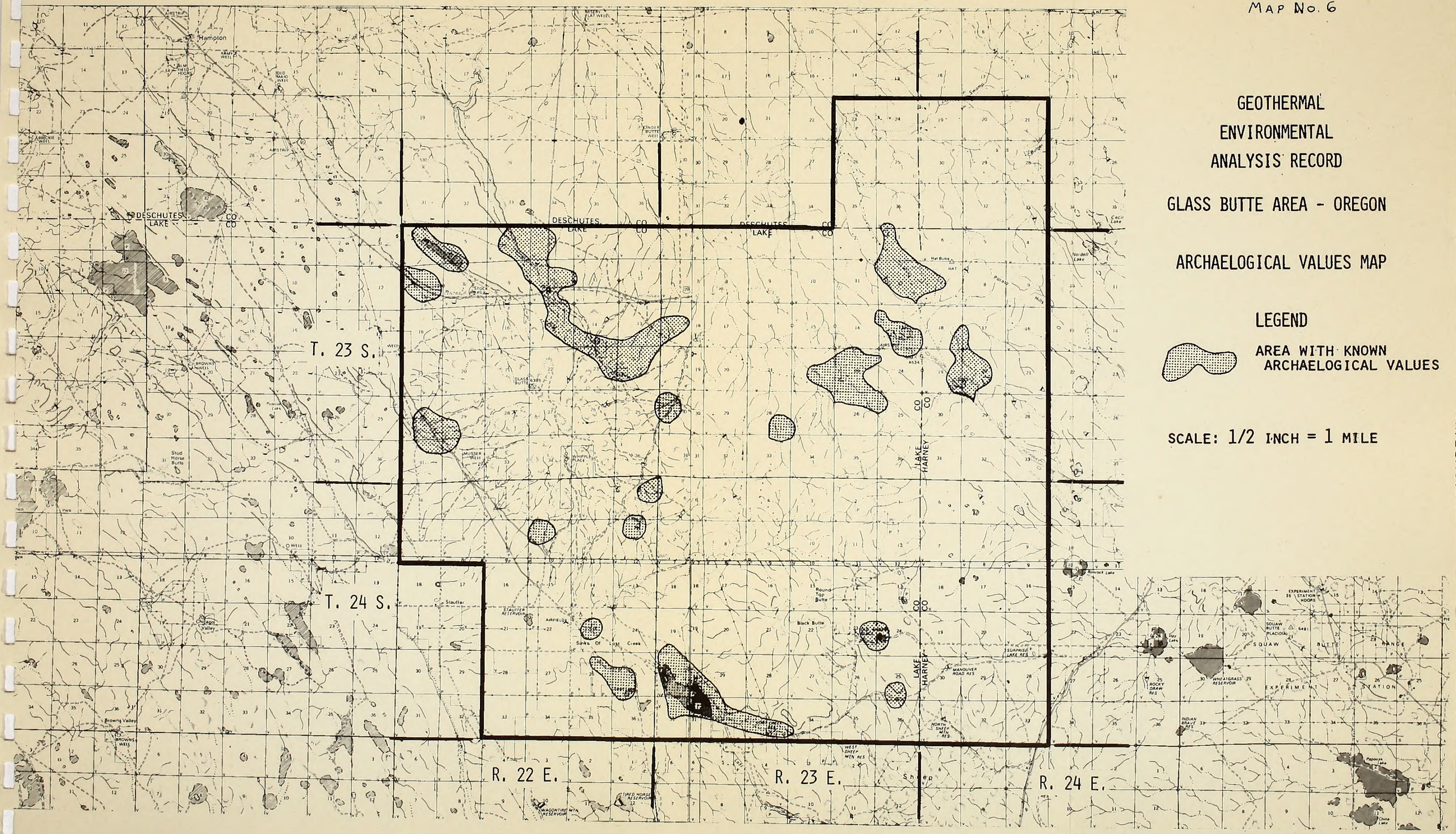
The proposed geothermal lease area lies in both Deschutes and Lake Counties. Comprehensive plans and zoning ordinances have been completed for both counties. Both counties have zoned their portion of the area under an A-2 zone (general agriculture). Commercial mining of minerals is allowed under this classification and while geothermal steam development is not specifically mentioned both counties felt that geothermal exploration and development with adequate environmental controls would be consistent with the intent of the zoning

MAP No. 6

GEOTHERMAL ENVIRONMENTAL ANALYSIS RECORD

GLASS BUTTE AREA - OREGON

ARCHAELOGICAL VALUES MAP



LEGEND

AREA WITH KNOWN ARCHAELOGICAL VALUES

SCALE: 1/2 INCH = 1 MILE

Both counties are actively involved in land use planning and seem able to make some planning decisions. The degree of integrity of county planning is closely monitored and greatly influenced by the Oregon State Land Conservation and Development Commission. This source of expertise and support make counties more willing to implement land use regulations. Present levels of man power and funding however, limit the counties ability to enforce land use plans and ordinances as completely as they would like.

III. ANALYSIS OF THE PROPOSED ACTION AND ALTERNATIVES

A. Proposed Action

1. Environmental Impacts

a. Anticipated Impacts

These will be considered in terms of four phases of implementation: exploration, development, operation, and close out.

(A) Exploration

(1) Non-Living Components

(a) Air - The type and amount of gases and vapors released during geothermal exploration is unknown because no drilling of this type has been done in the region. Noxious and/or toxic gases could be accidentally released to the atmosphere. Pollution from particulate matter would be dust from construction activities of roads, trails, and drill pads and vehicle use of these facilities. Engine combustion pollutants also would be increased as would the possibility of accidental fire with resultant smoke.

(b) Land - Soil erosion would be increased due to channeling of runoff water from construction of temporary roads and trails. Clearing and leveling drill pads would contribute to soil disturbance. An accidental blowout could cause extensive soil erosion and contamination.

(c) Water - The only surface water in the area is located in stock ponds and springs. These might be affected if increased erosion caused siltation of the reservoirs. Highest impact could come

to subsurface waters. Steam or hot brine could be brought into contact with fresh water bearing strata and could pollute or deplete the fresh water supply used for stockwatering. Health standard limits might be exceeded by dissolved solids in produced water.

(2) Living Components

The effects of exploration upon the living components would vary according to the method used. There would be negligable effect from airborne exploration such as aerial photography to a more severe impact from offroad vehicle use and test drilling.

(a) Plants (Aquatic) - Any exploration in or near springs could alter or destroy any existing aquatic vegetation.

(b) Plants (Terrestrial) - Offroad vehicle use would cause destruction of plant life and generally create new roads wherever the vehicles travel. Road and trail construction eliminates existing vegetation and opens the area to less desirable species for wildlife and domestic stock. Construction of drill pads would also eliminate vegetation in a localized area. The ecologic study area in T. 23 S., R. 23E., would be greatly damaged by any surface disturbance. It will be necessary to preclude surface occupancy of this site.

The discovery of a threatened or endangered plant in a proposed development area would necessitate action to protect the plant's habitat. Rehabilitation of exploration sites should have a beneficial effect upon the plant community.

(c) Animals (Aquatic) - There are no resident populations of aquatic animals in the area. Any animals passing through, such as ducks could be frightened from the immediate area of exploration.

(d) Animals (Terrestrial) - Intensive on-the-ground exploration could frighten animals from the immediate area. This should only be a short term effect with animals returning once exploration is completed. Exploratory drilling near any springs or seeps could frighten animals

from their normal watering area. Drilling in or near the identified sage grouse strutting ground could prevent the birds from using the area, particularly during the critical spring months.

(3) Ecological Interrelationships

Ecological interrelationship would be interrupted within limited areas. Vegetation would be eliminated with new vegetation taking its place. This new vegetation could be more desirable for wildlife and livestock or some areas could be invaded by less desirable species. Rehabilitation would aid in establishing desirable vegetative species. New and/or changed ecological systems could be established with the development of water areas and new vegetation species. With new vegetation, additional animals could come into the area.

Toxic substances could eliminate vegetation and animal species within limited areas.

(4) Human Values

(a) Landscape Character - During Exploration it is unlikely that significant landscape character changes would take place. The amount of impact would be determined by location of exploration wells and road construction. The character and natural harmony of a portion of the area could be changed.

Preliminary exploration and testing would have an impact on recreational use. Excessive traffic over primary roads and public access restrictions to certain areas would create conflicts. Some existing roads would be improved and new access roads would be constructed into previously inaccessible areas. These actions could expand rockhounding opportunities through increased access and possible discovery of new digging areas.

(b) Socio-Cultural Interests - Impacts on archeological and other cultural values would occur. The archeological survey report shows the average archeological site covers approximately 3.6 acres. By assuming there are approximately 771 sites within the lease area, this would

indicate that nearly 2800 acres or 2.5% of the 110,000 acre lease area possesses cultural values which could be destroyed by surface disturbing activities. Damage to the historic value of the Meeks' Trail, which passes through the area is not expected. No physical remnants of the trail exist and its exact location is not known.

Because of the sparse population of the area no problems are anticipated between local residents and the few temporary employees present during exploration.

(B) Development

(1) Non-Living Components

This phase will result in environmental impacts which are similar in kind to those during the exploration phase only the impacts could be much more intensive over larger areas.

(a) Air - Air pollution will be noticeable during this heavy construction period. Permanent roads, pipeline routes, transmission lines, drillpads, and power plants will result in soil disturbance and release of dust to the air. Increased road use will cause dust. Vehicle and stationary power equipment will release engine pollutants to the air. During drilling and testing of wells geothermal vapors will be released to the air with the possibility of noxious and toxic gases contained in the vapors.

(b) Land - The land surface at particular sites would be highly impacted during this phase. Permanent facilities constructed would include: drill pads, permanent access roads, steam pipelines, power transmission lines and electric power generation plants. All of these construction activities would have a permanent effect on the land surface and could cause increased soil erosion. An accidental well blow-out is a possibility during this phase which could cause much fluid to escape and cause extensive soil erosion.

(c) Water - A blow-out or even leaking casings on a shut-in well could cause contamination of fresh ground-water supplies. Increased surface water flow could result from a blow-out or if sufficiently

fresh water is found it could be allowed to form new lakes or streams in the area.

(2) Living Components

(a) Plants (Aquatic) - Development in or near springs could destroy or alter the water source and therefore change or destroy the existing vegetation.

(b) Plants (Terrestrial) - All phases of development could have a detrimental effect on existing vegetation. Those having the greatest effect would be offroad vehicles, scalping for roads, drill pads and development sites, possible escape of toxic water or stream, construction of powerlines and cooling ponds. The adverse impact of construction would be high in those areas where development takes place. Sulfur dioxide may limit native plant survival and growth in the vicinity of emission venting.

(c) Animals (Aquatic) - Development in or near springs could alter or destroy the aquatic habitat and have an adverse effect upon aquatic animals. Development could also create additional aquatic habitat.

(d) Animals (Terrestrial) - Development would have a temporary adverse effect upon mammals and birds in the area. During heavy construction animals could be frightened away but should return after development is completed. Development of powerlines and steam lines could also present a hazard to mammals and birds. Larger animals and birds which do not tolerate human activity could suffer a permanent loss of habitat. Noxious gases could drive wildlife from the area around the geothermal site. Development in or near the sage grouse strutting ground could destroy the critical habitat of these birds.

(3) Ecological Interrelationships

Vegetation would be eliminated, new vegetation would take its place. In some areas the vegetation would be more desirable for wildlife and livestock. Other areas could be invaded by less desirable species. Many areas which are left bare would take many years before even the simplest plant can be established. New ecological systems could be established with the development of water areas and new vegetation species. With these new types additional animals could come into the area.

Toxic substances could eliminate vegetation and animal species in a limited area.

(4) Human Values

(a) Landscape Character - Significant changes in the character and natural harmony of the geothermal lease area would occur during the development phase. Actual physical changes to the landscape would be greatest during this phase of heavy construction, drilling and testing. This alteration of the landscape would significantly affect the view from U. S. Highway 20 for passing tourists and the character of the area for the 5,0000 plus recreationists who visit the area each year for rockhounding and other recreational pursuits.

The clearing and grading of powerplant sites, construction of access roads and trails, installation of steam pipelines and powerplant construction would result in vegetative and surface disturbance. Soil disturbance and movement disposal of vegetation and construction wastes, handling of materials, equipment supplies, etc. would result in temporary environmental impacts such as noise, dust, surface run-off, siltation, smoke, etc. Similarly, powerline construction may involve clearing of rights-of-way, construction of temporary and permanent access routes, erection of towers and lines, etc. Potential environmental impacts involve factors such as soil movement, erosion and siltation, dust, disposal of vegetative waste, etc. Where power lines involve relatively steep slopes, the potential of environmental damage is increased. Construction of generation and power transmission facilities would result in the alteration of the aesthetic qualities of the area by changing the land use to an industrial development. Landscape changes would result from the removal of vegetation, from soil disturbance to accomodate roads, buildings, steam wells, pipelines and transmission lines and from the man made structures placed upon the site. The impact would not only occur at the site but also on linear corridors occupied by power transmission lines and along steam pipelines that would lace the terrain radiating out from the power plants.

(b) Socio-Cultural Interests - This phase of geothermal activity could have the greatest effect on archeological and other cultural values. Even with the Geothermal Lease Stipulation 18, which is designed to protect and inventory archeological and cultural values, the

large amount of surface disturbance activity would increase the chance for accidental loss of this non-renewable resource.

The increase in population due to the high activity level would have a tremendous impact on the small retail businesses at Hampton and to a lesser degree the economics of Bend and Burns. Additional public services would have to be provided in the vicinity of Glass Butte.

This influx of new people and activity into the area would certainly be welcome to some of the current residents but would just as certainly be viewed as an intrusion by others. For these latter people the influx into the area of more people could be the most significant impact.

(C) Operation

(1) Non-Living Components

(a) Air - The operation phase would result in air pollution which is similar to the development phase. Gases would be released to the air during production and testing and through possible accidents. Road travel would be considerably less than previously, causing less dust and gasoline engine pollution.

(b) Land - Withdrawal of large amounts of fluids from subsurface formations could lead to possible ground subsidence and seismic activity. However, ground subsidence is not expected to be major in this area. Seismic activity could also result from any reinjection of waste fluids. Some more limited construction activity would also take place during this phase with accompanying impact on the land surface.

(c) Water - The fresh water aquifers in the area could be accidentally contaminated by the geothermal waters. Also, leaking casing could cause a depletion of fresh water aquifers by draining the subsurface zone.

Water needed for generating plant operation would probably have to come from fresh water aquifers. Severe draw-down or even depletion of the fresh water aquifers is possible.

If sufficiently fresh water, or demineralized water is available from the geothermal resource new reservoirs could be formed.

(2) Living Components

(a) Plants (Aquatic) - If sufficient quantities of

water are released during the operation phase and toxicity is low, aquatic habitats could be developed which would be favorable for aquatic plant establishment. Highly toxic water could create large sterile areas.

(b) Plants (Terrestrial) - The greatest impact to plant life is during the development phase. Once development is completed many areas could be revegetated. The Operation phase should have no major impact upon existing vegetation, except possibly where toxic gases are vented and thereby harm surrounding or downwind vegetation.

(c) Animal (Aquatic) - During operation cooling ponds could be developed which would be very beneficial to aquatic animals. Toxic substances could be detrimental to the development of any aquatic habitat.

(d) Animal (Terrestrial) - Small mammals and birds should return once the operation is established and become abundant around the area. Larger mammals such as deer and antelope should not return as quickly as small mammals and numbers would probably not be as great as originally in the area. Additional water supplied during operation could attract additional mammals into the area.

(3) Ecological Interrelationships

Most adverse effects upon ecological processes would have already taken place by the time the operation phase is reached. If new water areas are developed new ecological systems would result. With these new systems new types and additional animals could come into the area. Some limited new construction activities would result in further adverse effects on ecological processes.

(4) Human Values

(a) Landscape Character - For the most part, the impacts on landscape character would be less intense during operation than during the development phase. The electric generating and transmission facilities would already be in existence. The operations phase would continue to impact the landscape where new development wells are drilled and old, depleted wells are abandoned.

(b) Socio-Cultural Interests - There would still be a slight chance for accidental destruction of archeological and

cultural values due to new well drill and road construction. The population would be stabilized at enough personnel to operate the generating plant and man the permanently stationed drill rigs. These people would impact the Bend and Burns areas. The tax base established by geothermal development would improve the financial stability of the various local governments.

(D) Close Out

(1) Non-Living Components

(a) Air - When the wells are being capped and steam pipelines removed some vapors would be released to the atmosphere. The use of heavy equipment would create a lot of dust during the dismanteling and removal of equipment.

(b) Land - Surface damage would occur during equipment removal and might be similar in impact to those during the construction phase.

(c) Water - If wells are properly cemented and capped there would be no further possible subsurface impact. Removal of artifical surface water ponds could remove most or all of the surface water from the area.

(2) Living Components

(a) Plants (Aquatic) - If aquatic vegetation is established during the development and operation phase, provisions could be made to maintain the ponds and vegetation after close out. This would be highly beneficial to the area.

(b) Plants (Terrestrial) - Close out would have a low impact upon the area. Equipment and machinery can be moved over established roads. Surface reclamation and rehabilitation should show a beneficial effect.

(c) Animals (Aquatic) - Same provisions could be made as for for aquatic plants. The impact should be highly beneficial.

(d) Animals (Terrestrial) - Animals should decrease during the actual closeout operation but populations should build back up to original levels. If additional water is present population totals may increase.

(3) Ecological Interrelationships

Close out could have some very important effects on any ecological

systems which resulted from the developments and operation of the area for geothermal resources. The removal of equipment and cessation of operations could destroy those systems which developed because the geothermal resource was being exploited. If water related eco-systems were developed it might be necessary to to provide for their continuance. With complete removal the former eco-systems might re-establish themselves in some areas.

(4) Human Values

(a) Landscape Character - The landscape would again be changed when equipment, wells, generating plants, and pipelines are removed from the depleted geothermal field. Some new scars would be caused and areas that have been previously revegetated would be denuded again. During close out, an an attempt would be made to return the area to its original condition and away from the industrial site it had become. This would lessen the visual impact.

(b) Socio-Cultural Interests - Cultural resources would be impacted to the extent that new surface disturbing activities are demanded by close-out activities. The close-out phase would cause a decline in the tax base of the area and a decrease in permanent population. The financial stability of the local governments could be upset by the loss of income.

B. Possible Mitigating or Enhancing Measures

Mitigation of most potential environmental problems and impacts from geothermal leasing can be accomplished through enforcement of applicable Federal, State, and local laws and regulations, geothermal exploration and leasing regulations, geothermal operating regulations, Geothermal Resource Operational Orders (GRO), lease and land use permit stipulations, and application of existing and yet to be developed technologies.

Most potential and anticipated impacts due to geothermal development of the area have been considered. Any unanticipated environmental impacts which become apparent

as a result of geothermal development should be mitigated before implementation of a plan of operation.

Most of the following possible mitigating and enhancing measures are covered under the Geothermal Resources Operation Order 4 (GRO no. 4), "General Environmental Protection Requirements." Listed after each possible mitigating measure is the section that covers that particular measure. (See Appendix VIII - GRO Orders).

(a) Exploration Phase

The following measures could be applied:

(1) Restrict off-road vehicular travel during spring or when soils are wet. (GRO no. 4, Section 2).

(2) Restrict all vehicular travel to existing roads and trails as much as possible. (GRO no. 4, Section 2).

(3) Heavily used roads may require surfacing (gravel) to reduce dust. (GRO no. 4, Section 3).

(4) Scarify and reseed to native species new roads if no longer needed. (GRO no. 4, Section 2)

(5) Contour and reseed all disturbed areas if possible. (GRO no. 4, Section 2).

(6) Surface permanent drill sites to reduce dust and erosion (GRO no. 4, Section 3).

(7) If toxic materials are present in fluids (drilling or geothermal) fence or otherwise prevent animal access (GRO no. 4, Section 4).

(8) Antiquities and objects of historic value will be protected as per special geothermal lease stipulation of the same title and GRO no. 4 Section 7.

(9) Provide continuing access for recreational rockhounders and protection of recreationist from possible dangers involved in geothermal resource projects. (GRO no. 4, Section 3).

(10) Allow no surface occupancy of those portions of Sections 13, 14, 15 T. 23S., R. 23 E which are included in the ecologic study area.

(11) Restrict all drilling activity within ½ mile radius of sage grouse strutting ground from March 1 through May 1. (Sec. 27, T. 23 S., R. 23 E.)

(B) Development Phase

All possible mitigating measures mentioned under the Exploration Phase are also pertinent during this phase. In addition, the following could also be applied.

(1) More heavily used roads may require surfacing. (GRO no. 4, Section 3).

(2) Any road or areas (drill site) to be used year-round need to be surfaced. (GRO no. 4, Section 3).

(3) Muffling devices on equipments will be required to bring noise to allowed safety levels (GRO no. 4, Section 11).

(4) All produced geothermal fluids will be monitored to prevent them from becoming a hazard. (GRO no. 4, Section 9)

(5) Power generation plants will be designed to harmonize with the natural forms, lines and colors of the soils, vegetation and land surface and be out of sight as much as possible. (GRO no. 4, Section 1)

(6) Design power transmission lines to prevent raptor electrocution. Design towers and lines to be low light reflective. (GRO no. 4, Section 6).

(7) Route power transmission lines away from immediate foreground along main travel routes with vegetative removal only for tower bases. Select locations to avoid silhouetting tower on skylines. (GRO no. 4, Section 1).

(8) Public hazards and user conflicts could be reduced by implementing an effective visitor information program. (GRO no. 4, Section 3).

(9) Each plan of operation will need a Monitoring Plan for monitoring emissions associated with development and operation (GRO no. 4, Section 9).

(10) Allow no permanent structures within ¼ mile

radius of sage grouse strutting ground. (Sec. 27, T. 23 S., R. 23 E).

(C) Operation Phase

Most possible mitigating measures mentioned under the Exploration and Development Phases are also pertinent to this phase. Continued development would be taking place so impacts would be continuing as before. In addition, the following measures may be taken depending on the type(s) of fluid found in the area.

(1) If fluid holding/evaporation ponds are necessary and fluids are toxic, areas must be fenced and otherwise protected from animal entry. If of high water quality develop animal habitat. (GRO no. 4, Section 6).

(2) If reinjection of fluids is necessary, safe re-injection would be handled in accordance with 30 CFR Part 270.

(D) Close-Out Phase

(1) Recontour all disturbed sites when possible and necessary to return area to near original condition. (GRO no. 4, Section 2)

(2) Revegetate all disturbed sites with species native to the area. (GRO no. 4, Section 2).

(3) If aquatic habitat has been established provide for its continuance. (GRO no. 4, Section 6).

All possible measures could be taken to return area to as near its original condition as possible. If enhancing measures have been taken, provide for their perpetuation.

C. Recommendations for Mitigation or Enhancement of Impacts

As covered in the preceding section, mitigation of most potential environmental problems and impacts from geothermal leasing can be accomplished through enforcement of applicable Federal and State laws and regulations, geothermal exploration and leasing regulations, geothermal operating regulations, Geothermal Resource Operational Orders, lease and land use permit stipulations.

Recommended lease stipulations which are not covered by the previously mentioned regulations, orders, and stipulations are listed here.

(A) Allow no surface occupancy of those portions of Sections 13, 14, 15 T. 23 S., R. 23 E. which ae included in the ecologic study area.

(B) Backfilling, final grading, revegetation and removal of surface supporting facilities shall be completed within one year after completion or termination of the particular operation involved, unless the Authorized Officer extends such time.

(C) Operations within 600 feet of any surface waters or wet soil areas such as streams, springs, seeps, reservoirs, or meadows will be permitted only if specifically approved in writing by the Authorized Officer and the Supervisor.

(D) No drilling shall be allowed within a one-half (½) mile radius of the sage grouse strutting ground in Section 27, T. 23S., R. 23 E. from March 1 through May 1. No permanent structures shall be allowed within a one-quarter (¼) mile radius of the sage grouse strutting ground.

D. Residual Impacts

Geothermal regulations, Geothermal Resources Operational Orders, and lease provisions are designed to assure development and utilization of geothermal resources in an environmentally acceptable manner. However, virtually any human use of lands and their resources may have some adverse impact. Where adverse impacts have been adequately recognized, mitigated to the extent possible and the benefits warrant acceptance of any residual impacts, such use of the lands and resources may be appropriate. Unavoidable adverse impacts in the different phases of activity are covered in the following discussion.

(A) Exploration Phase

Increased vehicular travel would produce dust, engine pollutants, noise, wildlife disturbance, and increased chances for accidents. Vegetative cover and soil would be disturbed by cross-country travel. Construction of new roads would change landscape contours.

For drilling operations of a geothermal resource test well existing roads might need to be enlarged resulting in impacts to vegetative cover, soil, and landscape contour. A well site of from one-half to three acres would be highly impacted. If drill sites are situated on steep sidehills considerable contour changes would be necessary for the drill site and access road. Noise levels would be moderate during drilling operations.

If a blowout occurs significant air, land, and water contamination could take place. Venting of steam, gases, and water would create

high noise levels, cause soil erosion and contamination, and possible injury to workers. The seriousness of the incident could range from minor to major depending on location, type of geothermal resource and time required to control. Concentrations of noxious or toxic gases could annoy or endanger humans and animals. Vegetation could be damaged by venting gases.

The fact of increased presence of men and equipment would present higher than normal fire hazard. Range fires could damage local environments.

(B) Development Phase

Since this phase also includes the procedure followed in the Exploration phase, residual impacts would continue to occur as previously mentioned plus the following as a result of production testing.

Testing of a vapor-dominated geothermal system would necessitate release of high volumes of steam. High noise levels and gas emissions would be unavoidable. Depending on the contents of the steam, noxious gases might be released which could bother humans, wildlife and vegetation.

Testing of a water-dominated system would require releasing large amounts of liquids which could contain salts or toxic substances. Even if properly contained these materials could damage wildlife and soil.

This phase would require greatly increased construction activity for pipelines, new wells, steam generating plants and power transmission lines. This would create additional noise, dust, vegetation clearance, and contour changes. The nature of the site would be changed from the present state to an industrial complex.

(C) Operation Phase

During operation of a field, activities would continue as before with the resultant residual impacts. Also, during this phase the following would be additional residual impacts.

Possible land subsidence and/or seismic activity might be induced although it is not likely in the Glass Butte area. Visual impact would be very high with the area having been changed from a grazing, hunting, and rockhounding area to an industrial site. Aesthetic values of the region would be highly impacted. Extensive development might lead to damage of archeological sites depending on the amount of damage to the site prior to it being recognized.

A change in wildlife species would unavoidably occur. Raptorial birds, pronghorn antelope, and other disturbance sensitive wildlife would permanently vacate the area. More tolerant species such as the numerous rodents and insects would continue to occupy areas of suitable habitat. Additional species, not now common to the area might occupy newly created habitat.

Livestock forage would be lost due to physical presence of on the ground facilities and restriction on animal access to some areas.

Some areas of traditional rockhounding use could be lost to the rockhounding public. Safety of visitors and protection of equipment could require restrictions on access to some digging sites.

Even though all archeological values would be identified, some would be unavoidably destroyed.

E. Relationship Between Short-Term Use and Long-Term Productivity

General - The leasing of land for geothermal resource development would commit the geothermal resource and a portion of the land area for both short-term and possible long-term uses. The short-term use is concerned with the exploration phase at the end of which, if no commercial quantities of geothermal steam were found, no long-term use would take place. This short-term use might be intensive and continuous for short periods and periodic over several years. At the end of this period, except for landscape scars, the disturbed areas would be returned to near natural conditions in a short time. Vegetation changes might take place, animal use would return to near original, and except for landscape changes no evidence of exploration would be noticeable.

However, if exploration shows commercial geothermal steam, development and production of electric power and possibly water and mineral by-products could be expected to occur. In the future, (20 to 50 years) when the resource has been depleted the leases would terminate, facilities would be removed, and the land restored as much as practicable to its original condition. Relatively large areas of level land would remain, road cuts and fills, steam pipeline routes, etc. would remain visible. With restoration and natural vegetative recovery the area could be returned to a near natural setting except for landscape contour changes.

Geothermal Resource - In dealing with the geothermal resource (including fluids) long-term considerations are major. On a local or regional basis the power source could be very significant

over the long-term. The heat content of the earth would eventually be depleted, but within a few hundred years or less the resource may renew itself. Therefore, in a very long-term context, the resource might again be available for use.

Land Use In the short-term exploration phase, small areas would be highly impacted becoming industrial sites. If exploration were successful this might become a permanent use, but if unsuccessful, rehabilitation should return the area to near original condition and use. Visual impacts would generally be long-term due to possible vegetative change and landscape contour change.

During the long-term operation of a generating plant the area would be changed to industrial from wildlife habitat, recreation, and grazing. Many of these uses might remain on a reduced basis. Public access to some parts of the lease area would be restricted to protect the public and the facilities. After production has ceased and improvements removed the area could be returned to near its original use.

Wildlife - Exploration would have minor, generally short-term impacts in the loss of habitat near exploration activities. Development would cause long-term loss of greater areas of habitat and minor loss of birds from contact with electric power lines. Public access restriction would cause loss of hunting opportunities. Some animals would benefit from develo-ment in the expansion of their habitats.

Human Use - Human use of the area would not be seriously hampered during exploration. Development would preclude recreational rockhounding, hunting, and grazing use in some areas. The open space value and aesthetics of the area could be highly impacted over the long-term. Proper planning and regulation could mitigate much of this type of impact.

F. Irreversible and Irretrievable Commitments of Resources

a. The geothermal resource, including thermal energy and water, would be depleted. These might be renewable over a long time period.

b. Compaction and land subsidence could take place but would not be likely in the Glass Butte area.

c. Permanent landscape scars would result from roads, well sites, and generation plant sites. The degree of landscape alteration would depend on area developed.

d. Some wildlife habitat might be lost forever in that larger

mammals might not return to the area even after restoration.

e. The cultural resources that are impacted are non-rewable and the knowledge that they represent would be irretrievable.

B. Alternative - Decline to Lease

1. Environmental Impacts

a. Anticipated Impacts

There would be no impacts on the Glass Butte area. A decision to not allow geothermal leasing in the area would preclude any geothermal development because the Federal government is the majority land holder.

The energy which might have been produced at this site would have to be developed at some other site or by some other method. The use of fossil fuels to produce this energy might be more environmentally detrimental to some other area or areas and could deplete our non-renewable resources.

The geothermal energy source over a long time span could be renewable and therefore an intermittent perpetual source of energy. If the resource were not used it would naturally slowly dissipate itself to the atmosphere with no noticeable beneficial results.

b. Possible Mitigating or Enhancing Measures

None

c. Recommendations for Mitigation or Enhancement of Impacts

None

d. Residual Impacts

Same as Anticipated Impacts

2. Relationship Between Short-Term Use and Long-Term Productivity

Short-term and long-term needs for increased electric power would have to be met in other areas and/or by other means. A long-term loss would be the slow dissipation of the geothermal resource without its beneficial use. Eventually the resource would probably

deplete itself to the point of no economic value.

3. Irreversible and Irretrievable Commitments of Resources

Resources in other areas and/or other types would be committed to generate the power that the geothermal resource might generate in this area.

IV. PERSONS, GROUPS, AND GOVERNMENT AGENCIES CONSULTED

A letter requesting any information regarding impacts brought about by geothermal leasing was sent to a number of groups and government agencies. A copy of the letter and a list of those it was sent to is to be found in Appendix IX. Also in the same appendix are the responses received.

No public meetings were held to specifically consider the Glass Butte area.

V. INTENSITY OF PUBLIC INTEREST

Nature and Level of Controversy

There is little if any controversy surrounding the proposed leasing in the Glass Butte area. The majority of people contacted are not overly concerned with this particular area.

A group of people in the Bend area, centered on the "Concerned Citizens for Newberry Crater", are generally against geothermal development in Central Oregon but mainly against leasing and development in the Newberry Crater area.

VI. PARTICIPATING STAFF

A team approach was used to develop this Environmental Analysis.

Members of the team were:

Dennis L. Davis - Team Leader - Geologist - Prineville District
Roger Wickstrom - Range Conservationist - Prineville District
Brian Cunninghame - Recreational Planner - Prineville District
Larry Todd - Range Conservationist - Burns District
Darwin Jeppesen - Soil Scientist - Prineville District

VII. SUMMARY CONCLUSIONS

The major residual impacts of the proposed action include some short term economic instability in local communities and community services, landscape contour changes, and if any accidental blowout occurs the short term venting of gases and liquids with possible erosion and toxic fluid production.

If the relatively short exploration phase is unsuccessful no subsequent development will take place and rehabilitation can be made. If an economic resource is found then development and production could occur over a 20 to 50 year period until the resource is depleted.

The main long term commitment is the depletion of the thermal energy and water from the geothermal reservoir. Rehabilitation of the geothermal field will take place after depletion of the resource.

Geothermal exploration and lease proposals in the Glass Butte area have received very limited response from the local public. This is based on the responses received from inquiries.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

Sheet A

ENVIRONMENTAL ANALYSIS WORKSHEET

1. Action

ISSUE GEOTHERMAL LEASES FOR GLASS BUTTE AREA

2. Stages of implementation

EXPLORATION

3. DISCRETE OPERATIONS	Airborne	Off-Road Vehicle Travel	Road, Trail, Drill Pad Construction	Drilling	Rehabilitation	
4. COMPONENTS, SUBCOMPONENTS, AND ELEMENTS IMPACTED	**5. ANTICIPATED IMPACTS**					**6. REMARKS**
I. NONLIVING COMPONENTS						
A. AIR						
Temperature	0	0	0	X	0	
Particulate Matter	0	-L	-L	-L	-L	
Engine Combustion Particles	0	-L	-L	-L	-L	
Toxic/Noxious Gases	0	0	0	X	0	Found with natural geothermal steam.
B. LAND						
Soil Properties	0	X	-M	-L	+L	
Soil Erosion	0	-L	-M	-L	+M	
Geologic Structure	0	0	X	-L	0	
Land Use Compatability	0	0	-L	X	X	
Land Use Suitability	0	0	-L	X	X	
C. WATER						
Sediment Load	0	-L	-L	-L	+L	Amount of water in area will depend on type of geothermal system.
Dissolved Solids	0	0	X	X	X	
Chemicals, Heavy Metals & Toxic Substances	0	0	0	X	X	
Nutrients	0	0	X	X	X	
Temperature	0	0	0	X	X	
II. LIVING COMPONENTS						
A. PLANTS *(Aquatic)*						
Vascular	0	X	X	X	0	
Phytoplankton	0	X	X	X	0	
Floating	0	X	X	X	0	

(Continued on reverse)

Form 1790-3 (June 1974)

DISCRETE OPERATIONS

Sheet A (Cont'd.)

COMPONENTS, SUBCOMPONENTS, AND ELEMENTS IMPACTED	Airborn	Off-Road Vehicle Travel	Road, Trail, Drill Pad Construction	Drilling	Rehabilitation	REMARKS
II. LIVING COMPONENTS (Con.)						
B. PLANTS *(Terrestrial)*						
Lichens and Mosses	0	-L	-H	-H	+M	
Grasses	0	-L	-H	-H	+M	
Forbs	0	-L	-H	-H	+M	
Shrubs	0	-L	-H	-H	L	
Conifers	0	X	-L	X	L	
Broadleaf Trees	0	X	-L	X	L	
C. ANIMALS *(Aquatic)*						
Mammals	0	0	X	0	0	
Birds	0	0	X	0	0	
Amphibians and Reptiles	0	0	X	0	0	
Fish	0	0	x	0	0	
Invertebrates	0	0	X	0	0	
Zooplankton	0	0	X	0	0	
D. ANIMALS *(Terrestrial)*						
Mammals	0	-L	-L	-L	+L	
Birds	0	X	-L	-L	+L	
Reptiles	0	X	-L	-L	+L	
Invertebrates	0	X	-L	-L	L	
Man	0	X	-L	-L	L	
III. INTERRELATIONSHIPS						
A. ECOLOGICAL PROCESSES						
Succession	0	-L	-L	-L	+L	
Food Relationships	0	-L	-L	-L	+L	
IV. HUMANVALUES						
A. LANDSCAPE CHARACTER						
Harmonious Elements	0	-L	-M	-L	L	
Accentuating Elements	0	L	M	L	L	
B. SOCIOCULTURAL INTERESTS						
Educational - Scientific	+L	+L	0	+L	0	
Cultural Values	0	X	X	X	X	
Social Welfare	0	+L	+M	+M	+L	
Attitudes - Expectations	0	x	x	x	x	
Local Regulatory Structures	0	0	0	0	0	

INSTRUCTIONS

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   a. Worksheet is normally used to analyze *"Anticipated Impacts"* of action; *however*, it may be used to analyze *"Residual Impacts."* Worksheets may also be used to compare impacts before and after mitigating measures are applied.
   b. State viewpoint that best describes environmental impact. For example, a fence viewed down the fence line has greater impact than the same fence viewed over an entire allotment. Generally, narrow viewpoints better illustrate specific impacts, wide will broad viewpoints.
   c. Assumptions may be made to establish a base for analysis *(e.g. estimated time periods, season of year, etc.)*.

2. *Stages of implementation* – Identify different phases of proposed project *(e.g. a road project consists of survey, construction, use, and maintenance stages)*.

3. *Discrete Operations* – Identify separate actions comprising a particular stage of implementation *(e.g. the construction stage of the road project has the discrete operations of clearing, grading, and surfacing)*.

4. *Elements Impacted* – Enter under appropriate heading all environmental elements susceptible to impact from action and alternatives. Relevant elements not contained in the digest should also be entered. See BLM Manual 1791, Appendix 2, Environmental Digest.

5. *Anticipated Impact* – Evaluate anticipated impact on each element and place an entry in the appropriate square indicating degree of impact as low (L), medium (M), high (H), no impact (O), or unknown or negligable (X). Preceed each entry by a plus (+) or minus (–) sign indicating a beneficial or adverse type of impact. If type of impact reflects a matter of opinion or is not known, *do not* preceed with a sign. For example, construction of a wind mill on open range has a definite visual impact; *however*, to some people the effect is detrimental while to others it is an improvement. By not entering a plus (+) or minus (–) sign the worksheet is kept factual and unbiased. If both degree and type of impact are unknown, place an (x) in the appropriate square.
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6. *Remarks* – Enter clarifying information.

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

Sheet B

ENVIRONMENTAL ANALYSIS WORKSHEET

1. Action

ISSUE GEOTHERMAL LEASES FOR GLASS BUTTES AREA

2. Stages of implementation

DEVELOPMENT

3. DISCRETE OPERATIONS	Road Construction	Well Drill and Testing	Geothermal Pipe-Line Construction	General Plant Construction	Electric Transmission Line Construction	Rehabilitation	6. REMARKS
I. NONLIVING COMPONENTS							
4. COMPONENTS, SUBCOMPONENTS, AND ELEMENTS IMPACTED	**5. ANTICIPATED IMPACTS**						
A. AIR							
Temperature	0	X	0	0	0	0	
Particulate Matter	-L	-M	-M	-M	-L	-L	
Engine Combustion Particles	-L	-L	-L	-L	-L	-L	
Toxic/Noxious Gases	0	-M	0	0	0	0	Found with natural geothermal steam.
B. LAND							
Soil Properties	-M	-L	-M	-M	-L	+L	
Soil Erosion	-M	-L	-M	-M	-L	+M	
Geologic Structure	X	-L	X	X	X	0	
Land Use Compatability	-L	X	-H	-H	-M	X	
Land Use Suitability	-L	X	-L	-L	-L	X	
C. WATER							
Sediment Load	-L	-M	-L	-L	-L	+L	Amount of water in area will depend on type of geothermal system.
Dissolved Solids	X	X	X	X	X	X	
Chemicals, Heavy Metals, & Toxic Substances	0	X	0	0	0	X	
Nutrients	X	X	X	X	X	X	
Temperature	0	x	0	0	0	X	
II. LIVING COMPONENTS							
A. PLANTS *(Aquatic)*							
Vascular	X	X	X	X	X	0	
Phytoplankton	X	X	x	x	X	0	
Floating	x	X	X	X	X	0	

(Continued on reverse)

Form 1790-3 (June 1974)

Sheet B (Cont'd.)

DISCRETE OPERATIONS	Road Construction	Well Drill and Testing	Geothermal Pipe Line Construction	Generating Plant Construction	Electric Transmission Line Const.	Rehabilitation	
COMPONENTS, SUBCOMPONENTS, AND ELEMENTS IMPACTED	**ANTICIPATED IMPACTS**						**REMARKS**
II. LIVING COMPONENTS (Con.)							
B. PLANTS (*Terrestrial*)							
Lichens and Mosses	-H	-H	-H	-H	-M	+M	
Grasses	-H	-H	-H	-H	-M	+M	
Forbs	-H	-H	-H	-H	-M	+M	
Shrubs	-H	-H	-H	-H	-M	L	
Conifers	-L	X	-L	-L	-L	L	
Broadleaf Trees	-L	X	-L	-L	-L	L	
C. ANIMALS (*Aquatic*)							
Mammals	X	X	X	X	X	0	
Birds	X	X	X	X	X	0	
Amphibians and Reptiles	X	X	X	X	X	0	
Fish	X	X	X	X	X	0	
Invertebrates	X	X	X	X	X	0	
Zooplankton	X	X	X	X	X	0	
D. ANIMALS (*Terrestrial*)							
Mammals	-L	-H	-L	-L	-L	+L	
Birds	-L	-H	-L	-L	-M	+L	
Reptiles	-L	-H	-L	-L	-L	+L	
Invertebrates	-L	-H	-L	-L	-L	L	
Man	-L	-H	-L	-L	-L	L	
III. INTERRELATIONSHIPS							
A. ECOLOGICAL PROCESSES							
Succession	-L	-L	-L	-L	-L	+L	
Food Relationships	-L	-L	-L	-L	-L	+L	
IV. HUMAN VALUES							
A. LANDSCAPE CHARACTER							
Harmonious Elements	-M	-L	-H	-H	-M	L	
Accentuating Elements	M	L	H	H	M	L	
B. SOCIOCULTURAL INTERESTS							
Educational - Scientific	0	+L	L	L	X	0	
Cultural Values	X	X	X	X	X	X	
Social Welfare	+M	+M	+M	+M	+M	+L	
Attitudes - Expectations	X	X	X	X	X	X	
Local Regulatory Structures	0	0	0	0	0	0	

INSTRUCTIONS

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   b. State viewpoint that best describes environmental impact. For example, a fence viewed down the fence line has greater impact than the same fence viewed over an entire allotment. Generally, narrow viewpoints better Illustrate specific impacts than will broad viewpoints.
   c. Assumptions may be made to establish a base for analysis (*e.g. estimated time periods, season of year, etc.*).

2. *Stages of Implementation* – Identify different phases of proposed project (*e.g. a road project consists of survey, construction, use, and maintenance stages*).

3. *Discrete Operation* – Identify separate actions comprising a particular stage of implementation (*e.g. the construction stage of the road project has the discrete operations of clearing, grading, and surfacing*).

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Remarks – Enter clarifying information.

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UNITED STATES
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BUREAU OF LAND MANAGEMENT

Sheet c

ENVIRONMENTAL ANALYSIS WORKSHEET

1. Action

ISSUE GEOTHERMAL LEASES FOR GLASS BUTTES AREA

2. Stages of implementation

OPERATION

3. DISCRETE OPERATIONS	New Drill Sites And Drilling	Maintenance	Waste Disposal	Production		
4. COMPONENTS, SUBCOMPONENTS, AND ELEMENTS IMPACTED	**5. ANTICIPATED IMPACTS**					**6. REMARKS**
I. NONLIVING COMPONENTS						
A. AIR						
Temperature	X	0	L	L		
Particulate Matter	-M	-L	X	L		
Engine Combustion Particles	-L	-L	-L	-L		
Toxic/Noxious Gases	-M	-L	-M	-M		Found with natural geothermal steam.
B. LAND						
Soil Properties	-L	X	M	X		
Soil Erosion	-L	L	M	X		
Geologic Structure	-L	0	-M	-M		
Land Use Compatability	X	0	-H	X		
Land Use Suitability	X	0	X	X		
C. WATER						
Sediment Load	-M	0	-H	X		Amount of water in area will depend on type of geothermal system.
Dissolved Solids	X	0	-H	X		
Chemicals, Heavy Metals & Toxic Substances	X	0	-H	X		
Nutrients	X	0	H	X		
Temperature	X	0	H	X		
II. LIVING COMPONENTS						
A. PLANTS (Aquatic)						
Vascular	X	0	H	X		If waste evaporation ponds are created might develop aquatic habitat.
Phytoplankton	X	0	H	X		
Floating	X	0	H	X		

(Continued on reverse)

Form 1790-3 (June 1974)

Sheet C (Cont'd.)

DISCRETE OPERATIONS		New Drill Sites and Drilling	Maintenance	Waste Disposal	Production		
	COMPONENTS, SUBCOMPONENTS, AND ELEMENTS IMPACTED	ANTICIPATED IMPACTS					REMARKS
II. LIVING COMPONENTS (Con.)	B. PLANTS *(Terrestrial)*						
	Lichens and Mosses	-H	X	-H	X		
	Grasses	-H	X	-H	X		
	Forbs	-H	X	-H	X		
	Shrubs	-H	X	-H	X		
	Conifers	X	X	-M	X		
	Broadleaf Trees	X	X	-H	X		
	C. ANIMALS *(Aquatic)*						
	Mammals	X	0	H	M		Waste water might create aquatic
	Birds	X	0	H	M		habitat
	Amphibians and Reptiles	X	0	H	M		
	Fish	X	0	H	M		
	Invertebrates	X	0	H	M		
	Xooplankton	X	0	H	M		
	D. ANIMALS *(Terrestrial)*						
	Mammals	-H	X	M	M		
	Birds	-H	X	M	M		
	Reptiles	-H	X	M	M		
	Invertebrates	-H	X	M	M		
	Man	-H	X	M	M		
III. INTERRELATIONSHIPS	A. ECOLOGICAL PROCESSES						
	Sucession	-L	0	M	X		
	Food Relationships	-L	0	M	X		
IV. HUMANVALUES	A. LANDSCAPE CHARACTER						
	Harmonious Elements	-L	0	-H	0		
	Accentuating Elements	L	0	M	0		
	B. SOCIOCULTURAL INTERESTS						
	Educational - Scientific	+L	0	+L	+L		
	Cultural Values	X	0	0	0		
	Social Welfare	+M	+L	+L	+L		
	Attitudes - Expectations	X	0	X	X		
	Local Regulatory Structures	0	0	X	0		

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UNITED STATES
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BUREAU OF LAND MANAGEMENT

Sheet D

ENVIRONMENTAL ANALYSIS WORKSHEET

1. Action

ISSUE GEOTHERMAL LEASES FOR GLASS BUTTES AREA

2. Stages of implementation

CLOSE-OUT

3. DISCRETE OPERATIONS	Remove Surface Equipment and Revegetation	Surface Restoration				
4. COMPONENTS, SUBCOMPONENTS, AND ELEMENTS IMPACTED	**5. ANTICIPATED IMPACTS**					**6. REMARKS**
I. NONLIVING COMPONENTS						
A. AIR						
Temperature	0	0				
Particulate Matter	-L	-L				
Engine Combustion Particles	-L	-L				
Toxic/Noxious Gases	-L	0				Found with natural geothermal steam.
B. LAND						
Soil Properties	-L	+M				
Soil Erosion	-L	+M				
Geologic Structure	0	0				
Land Use Compatability	0	H				
Land Use Suitability	0	X				
C. WATER						
Sediment Load	X	X				
Dissolved Solids	X	X				
Chemicals, Heavy Metals, & Toxic Substances	0	0				
Nutrients	0	X				
Temperature	0	0				
II. LIVING COMPONENTS						
A. PLANTS *(Aquatic)*						
Vascular	X	H				
Phytoplankton	X	H				
Floating	X	H				

(Continued on reverse)

Form 1790-3 (June 1974)

Sheet D (Cont'd.)

	COMPONENTS, SUBCOMPONENTS, AND ELEMENTS IMPACTED	DISCRETE OPERATIONS: Remove Surface Equipment	Surface Restorat	and Revegetation			REMARKS
II. LIVING COMPONENTS (Con.)	B. PLANTS *(Terrestrial)*						
	Lichens and Mosses	-L	+H				
	Grasses	-L	+H				
	Forbs	-L	+H				
	Shrubs	-L	+H				
	Conifers	X	X				
	Broadleaf Trees	X	X				
	C. ANIMALS *(Aquatic)*						
	Mammals	X	H				
	Birds	X	H				
	Amphibians and Reptiles	X	H				
	Fish	X	H				
	Invertebrates	X	H				
	Zooplankton	X	H				
	D. ANIMALS *(Terrestrial)*						
	Mammals	X	M				
	Reptiles	X	M				
	Birds	X	M				
	Invertebrates	X	M				
	Man	X	M				
III. INTERRELATIONSHIPS	A. ECOLOGICAL PROCESSES						
	Succession	0	+L				
	Food Relationships	0	+L				
IV. HUMANVALUES	A. LANDSCAPE CHARACTER						
	Harmonious Elements	+H	+M				
	Accentuating Elements	M	M				
	B. SOCIOCULTURAL INTERESTS						
	Educational - Scientific	0	0				
	Cultural Values	0	0				
	Social Welfare	+M	+L				
	Attitudes - Expectations	X	L				
	Local Regulatory Structures	0	0				

INSTRUCTIONS

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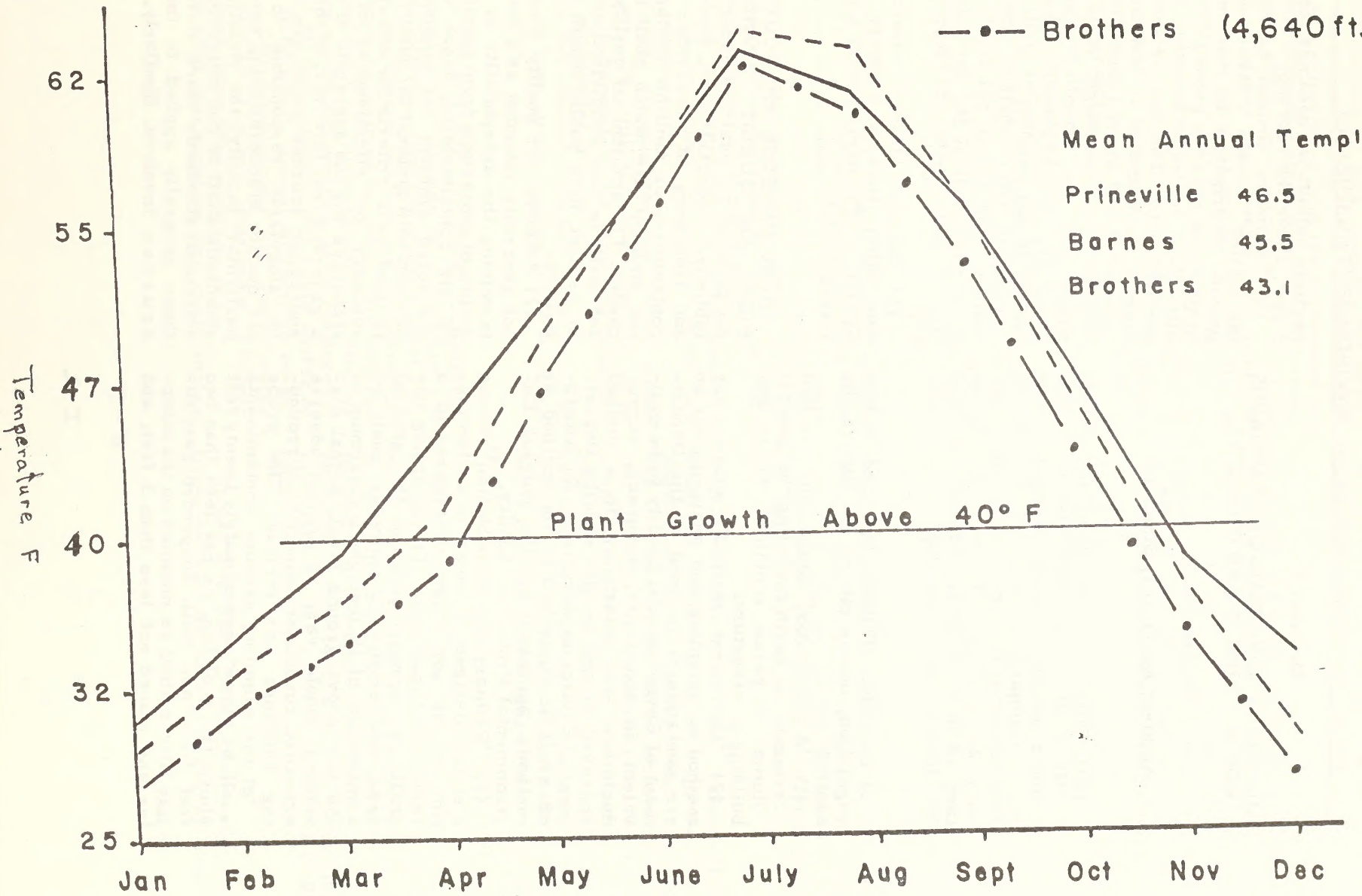
APPENDIX I

AIR

Air Temperatures
Monthly Means for Prineville (1937-67),
Barnes (1962-71) and Brothers (1960-71)



Division 3

AIR POLLUTION CONTROL STANDARDS FOR AIR PURITY AND QUALITY

Subdivision 1

Ambient Air Quality Standards

[ED. NOTE: Unless otherwise stated, sections 31-005 through 31-050 of this chapter of the Oregon Administrative Rules Compilation were adopted by the Department of Environmental Quality January 24, 1972 and filed with the Secretary of State February 15, 1972 as DEQ 37. Repeals DEQ 5 and 6.]

31-005 DEFINITIONS. As used in this regulation, unless otherwise required by context:

(1) "Ambient Air" means the air that surrounds the earth excluding the general volume of gases contained within any building or structure.

(2) "Equivalent Method" means any method of sampling and analyzing for an air contaminant deemed by the Department of Environmental Quality to be equivalent in sensitivity, accuracy, reproducibility and selectivity to a method approved by and on file with the Department of Environmental Quality. Such method shall be equivalent to the method or methods approved by the federal Environmental Protection Agency.

(3) "Primary Air Mass Station" means a station designed to measure contamination in an air mass and represent a relatively broad area. The sampling site shall be representative of the general area concerned. The sampler shall be a minimum of 15 feet and a maximum of 150 feet above ground level. Actual elevations should vary to prevent adverse exposure conditions caused by surrounding buildings and terrain. The probe inlet for sampling gaseous contaminants shall be placed approximately twenty feet above the roof top, or not less than two feet from any wall. Suspended particulate filters shall be mounted on the sampler and placed not less than 3 feet, and particle fallout jar openings not less than 5 feet, above the roof top.

(4) "Primary Ground Level Monitoring Station" means a station designed to provide information on contaminant concentrations near the ground. The sampling site shall be representative of the immediate area. The sample shall be taken from a minimum of 10 feet and a maximum of 15 feet above ground level, with a desired optimum height of 12 feet. The probe inlet for sampling gaseous contaminants shall be placed not less than two feet from any building or wall. Suspended particulate filters shall be mounted on the sampler and placed not less than 3 feet, or particle fallout jar openings not less than 5 feet, above the supporting roof top.

(5) "Special Station" means any station other than a Primary Air Mass Station or Primary Ground Level Monitoring Station.

31-010 PURPOSE AND SCOPE OF AMBIENT AIR QUALITY STANDARDS. (1) An ambient air quality standard is an established concentration, exposure time and frequency of occurrence of an air contaminant or multiple contaminants in the ambient air which shall not be exceeded. The ambient air quality standards set forth in this subdivison are designed to protect both public health and public welfare.

(2) Ambient air quality standards are not generally intended as a means of determining the acceptablilty or unacceptability of emissions from specific sources of air contamination. More commonly, measured ambient air quality in comparison with ambient air quality standards is used as a criteria for determining the adequacy or effectiveness of emission standards for the aggregate of sources in a general area. However, in the case of a source or sources which are deemed to be singularly responsible for ambient air quality standards being exceeded in a particular locality, the violation of said standards shall be due cause for imposing emission standards more stringent than those generally applied to the class of sources involved. Similarly, proposed

construction of new sources or expan-
ons of existing sources, which may pre-
nt or interfere with the attainment and maintenance of ambient air quality standards, shall be due cause for issuance of an order prohibiting such proposed construction, pursuant to ORS 449.712 and OAR Chapter 340, Section 20-030.

(3) In adopting the ambient air quality standards in this subdivision, the Environmental Quality Commission recognizes that one or more of the standards are currently being exceeded in certain parts of the State. It is hereby declared to be the policy of the Environmental Quality Commission to achieve, by application of a timely but orderly program of pollution abatement, full compliance with ambient air quality standards throughout the State at the earliest possible date, but in no case later than July 1, 1975.

31-015 SUSPENDED PARTICULATE MATTER. Concentrations of suspended particulate matter at a primary air mass
ion, as measured by a method approved by and on file with the Department of Environmental Quality, or by an equivalent method, shall not exceed:

(1) 60 micrograms per cubic meter of air, as an annual geometric mean for any calendar year.

(2) 100 micrograms per cubic meter of air, 24 hour concentration for more than 15 percent of the samples collected in any calendar month.

(3) 150 micorgrams per cubic meter of air, 24 hour concentration, more than once per year.

31-020 SULFUR DIOXIDE. Concentrations of sulfur dioxide at a primary air mass station, primary ground level station, or special station, as measured by a method approved by and on file with the Department of Environmental Quality, or by an equivalent method, shall not exceed:

(1) 60 micrograms per cubic meter of air (0.02 ppm), annual arithmetic mean.

(2) 260 micrograms per cubic meter of air (0.10 ppm), maximum 24-hour average more than once per year.

(3) 1300 micrograms per cubic meter of air (0.50 ppm) maximum 3 hour average, more than once per year.

31-025 CARBON MONOXIDE. Concentrations of carbon monoxide at a primary air mass station or primary ground level stations, as measured by a method approved by and on file with the Department of Environmental Quality or by an equivalent method, shall not exceed:

(1) 10 milligrams per cubic meter of air (8.7 ppm), maximum 8 hour average, more than once per year.

(2) 40 milligrams per cubic meter of air (35 ppm), maximum 1 hour average, more than once per year.

31-030 PHOTOCHEMICAL OXIDANTS. Concentrations of photochemical oxidants at a primary air mass station, as measured by a method approved by and on file with the Department of Environmental Quality, or by an equivalent method, shall not exceed 160 micrograms per cubic meter (0.08 ppm), maximum 1 hour average, more than once per year.

31-035 HYDROCARBONS. Concentrations of hydrocarbons at a primary air mass station, as measured and corrected for methane by a method approved by and on file with the Department of Environmental Quality, or by an equivalent method, shall not exceed 160 micrograms per cubic meter of air (0.24 ppm), maximum 3 hour concentration measured from 0600 to 0900, not to be exceeded more than once per year.

31-040 NITROGEN DIOXIDE. Concentrations of nitrogen dioxide at a primary air mass station, as measured by a method approved and on file with the Department of Environmental Quality, or by an equivalent method, shall not exceed 100 micrograms per cubic meter of air (0.05 ppm), annual arithmetic mean.

31-045 PARTICLE FALLOUT. The particle fallout rate at a primary air mass

station, primary ground level station, or special station, as measured by a method approved by and on file with the Department of Environmental Quality, or by an equivalent method, shall not exceed:

(1) 10 grams per square meter per month in an industrial area, or

(2) 5.0 grams per square meter per month in an industrial area if visual observations show a presence of wood waste or soot and the volatile fraction of the sample exceeds seventy per cent (70%),

(3) 5.0 grams per square meter per month in residential and commercial areas, or

(4) 3.5 grams per square meter per month in residential and commercial areas if visual observations show the presence of wood waste or soot and the volatile fraction of the sample exceeds seventy per cent (70%).

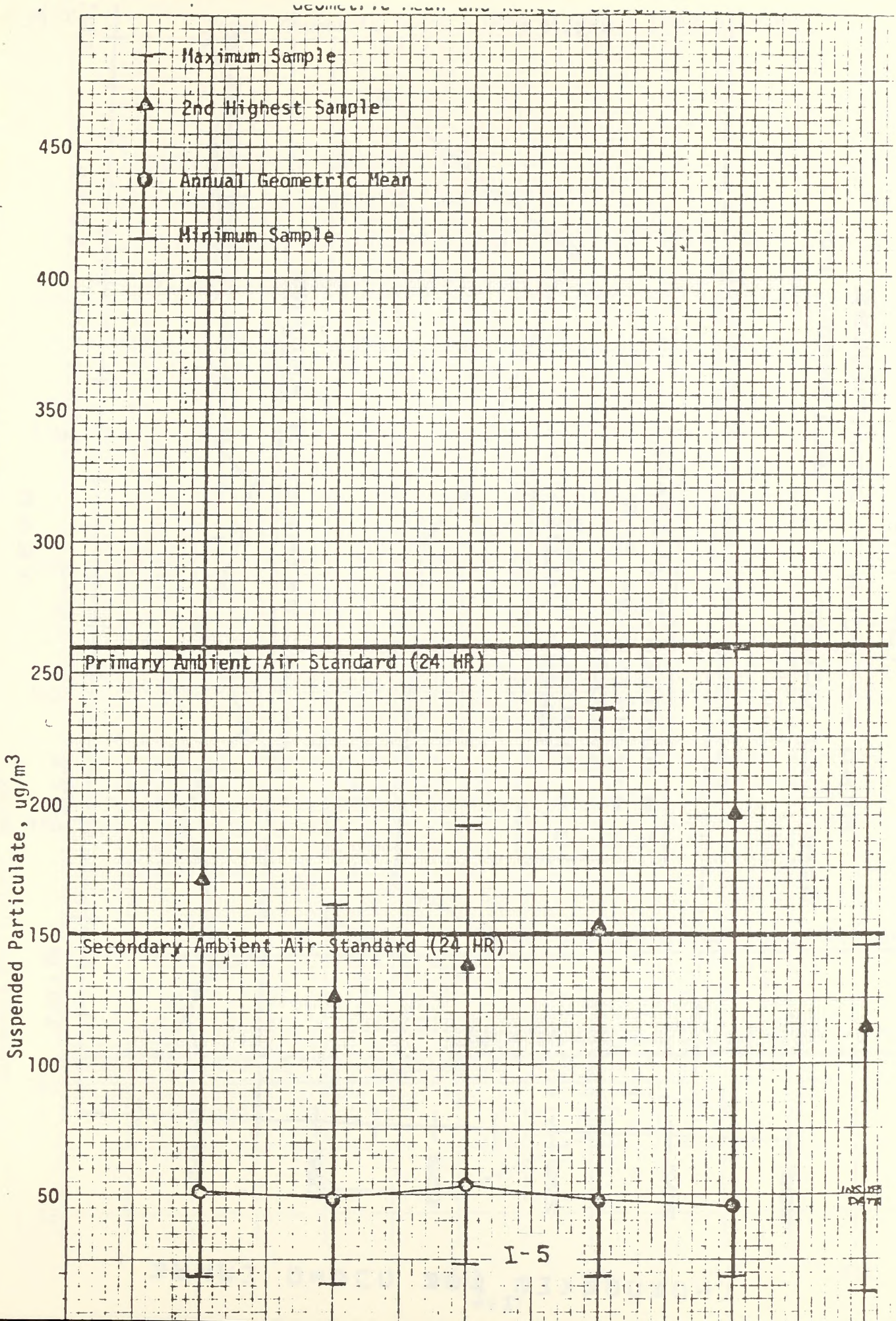
31-050 CALCIUM OXIDE (Lime Dust).

(1) Concentrations of calcium oxide present as suspended particulate at a primary air mass station, as measured by a method approved by and on file with the Department of Environmental Quality, or by an equivalent method, shall not exceed 20 micrograms per cubic meter in residential and commercial areas at any time.

(2) Concentrations of calcium oxide present as particle fallout at a primary air mass station, primary ground level station, or special station, as measured by a method approved by and on file with the Department of Environmental Quality or by an equivalent method, shall not exceed 0.35 grams per square meter per month in residential and commercial areas.

31-055 AMBIENT AIR QUALITY STANDARD FOR LEAD. The lead concentration measured at any individual sampling station, using sampling and analytical methods on file with the Department, shall not exceed 3.0 ug/m^3 as an arithmetic average concentration of all samples collected at that station during any one calendar month period.

Hist: Filed 1-29-75 as DEQ 85
Effective 2-25-75.


Maximum Sample
2nd Highest Sample
Annual Geometric Mean
Minimum Sample
450
400
350
300
250
200
150
100
50
Primary Ambient Air Standard (24 HR)
Secondary Ambient Air Standard (24 HR)
Suspended Particulate, ug/m3
46 0782
K+E 10 X 10 TO THE INCH • 7 X 10 INCHES
KEUFFEL & ESSER CO. MADE IN U.S.A.

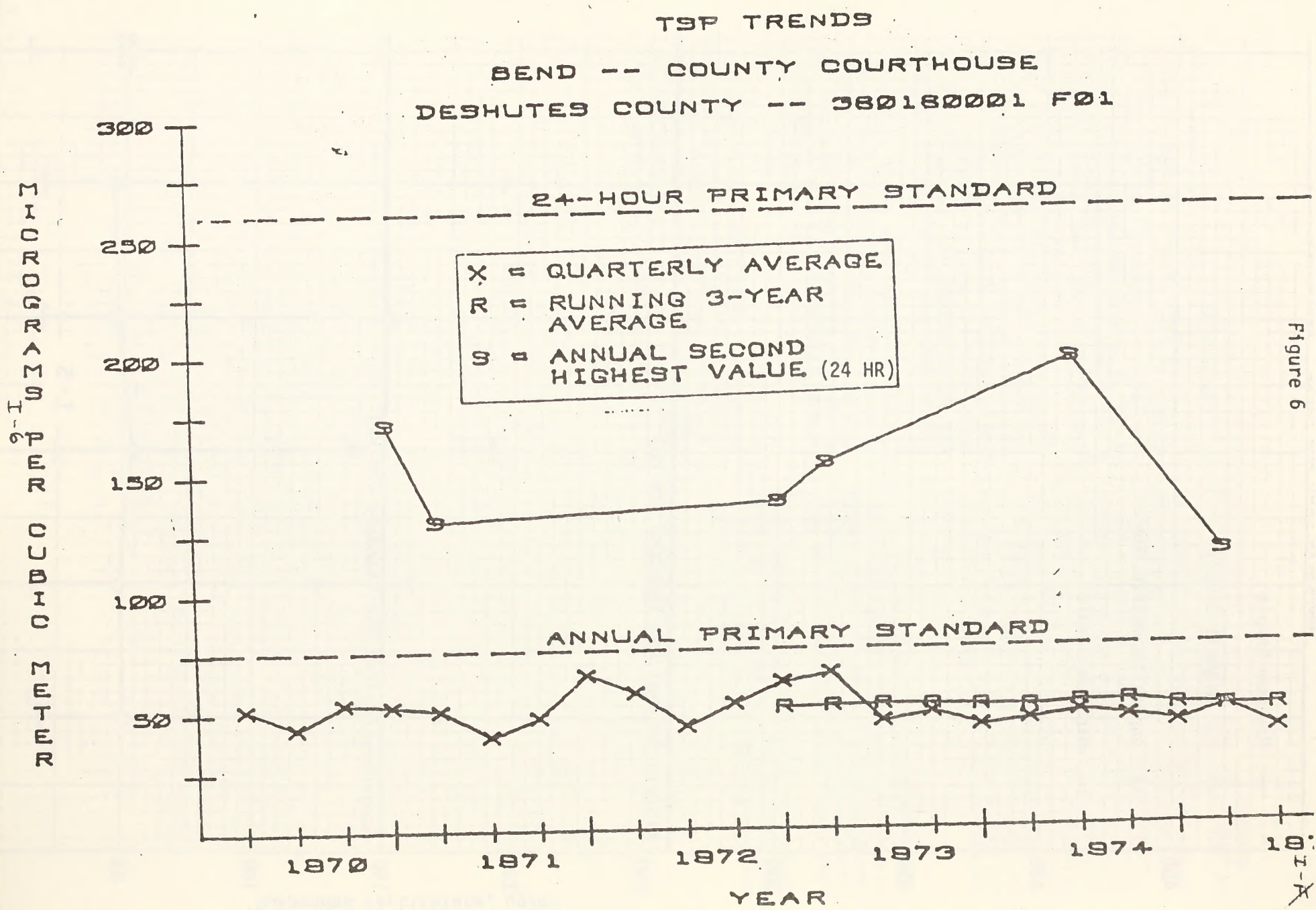

TSP TRENDS
BEND -- COUNTY COURTHOUSE
DESHUTES COUNTY -- 380180001 F01
24-HOUR PRIMARY STANDARD
ANNUAL PRIMARY STANDARD
X = QUARTERLY AVERAGE
R = RUNNING 3-YEAR AVERAGE
S = ANNUAL SECOND HIGHEST VALUE (24 HR)
MICROGRAMS PER CUBIC METER
300
250
200
150
100
50
1970
1971
1972
1973
1974
YEAR

Figure 6

Annual Geometric Means - Central Oregon IAQCR Stations

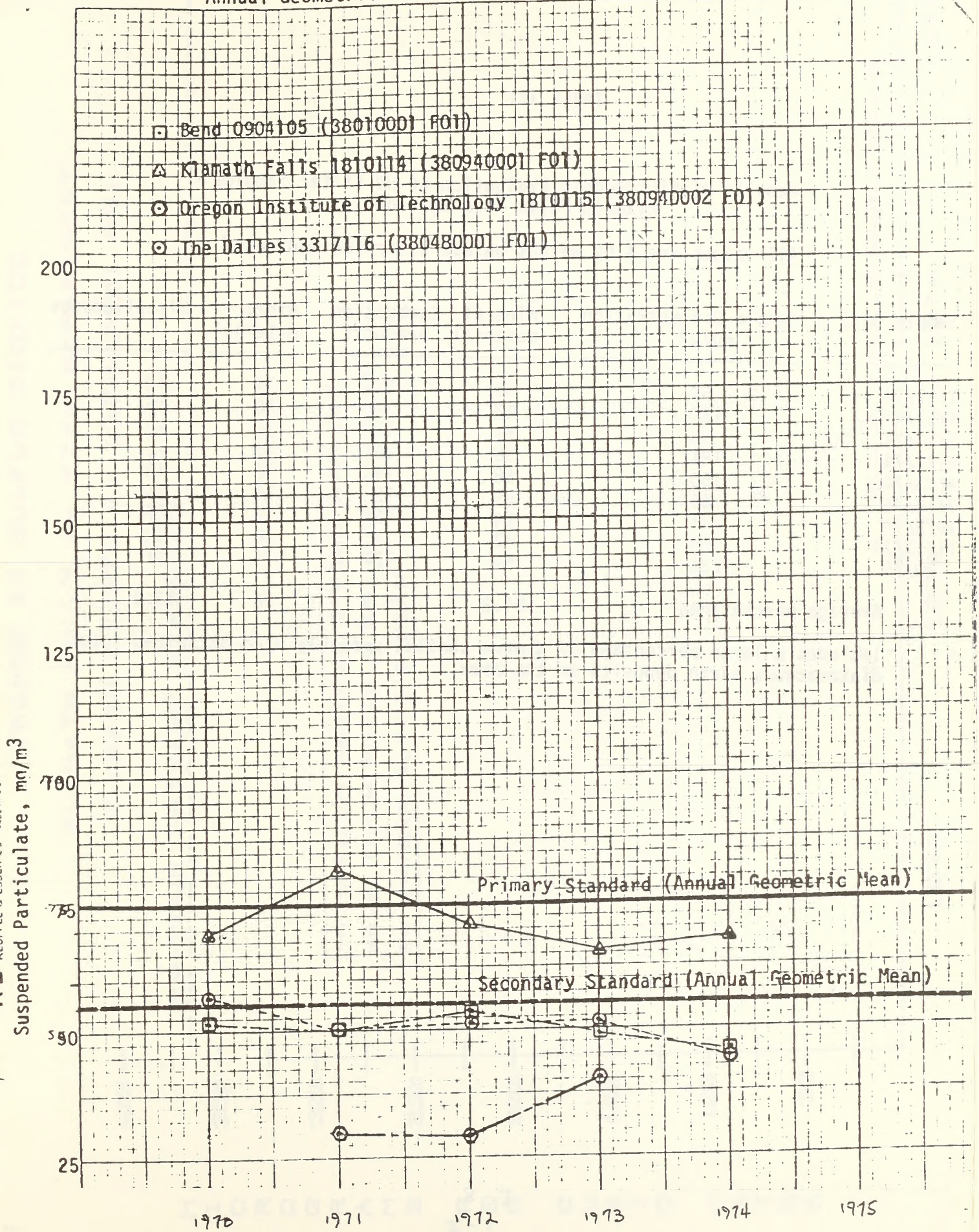


TABLE III

Results of Microscopic Evaluation of HV Filter Samples
Klamath Falls Fire Station

All values are % by weight unless otherwise indicated

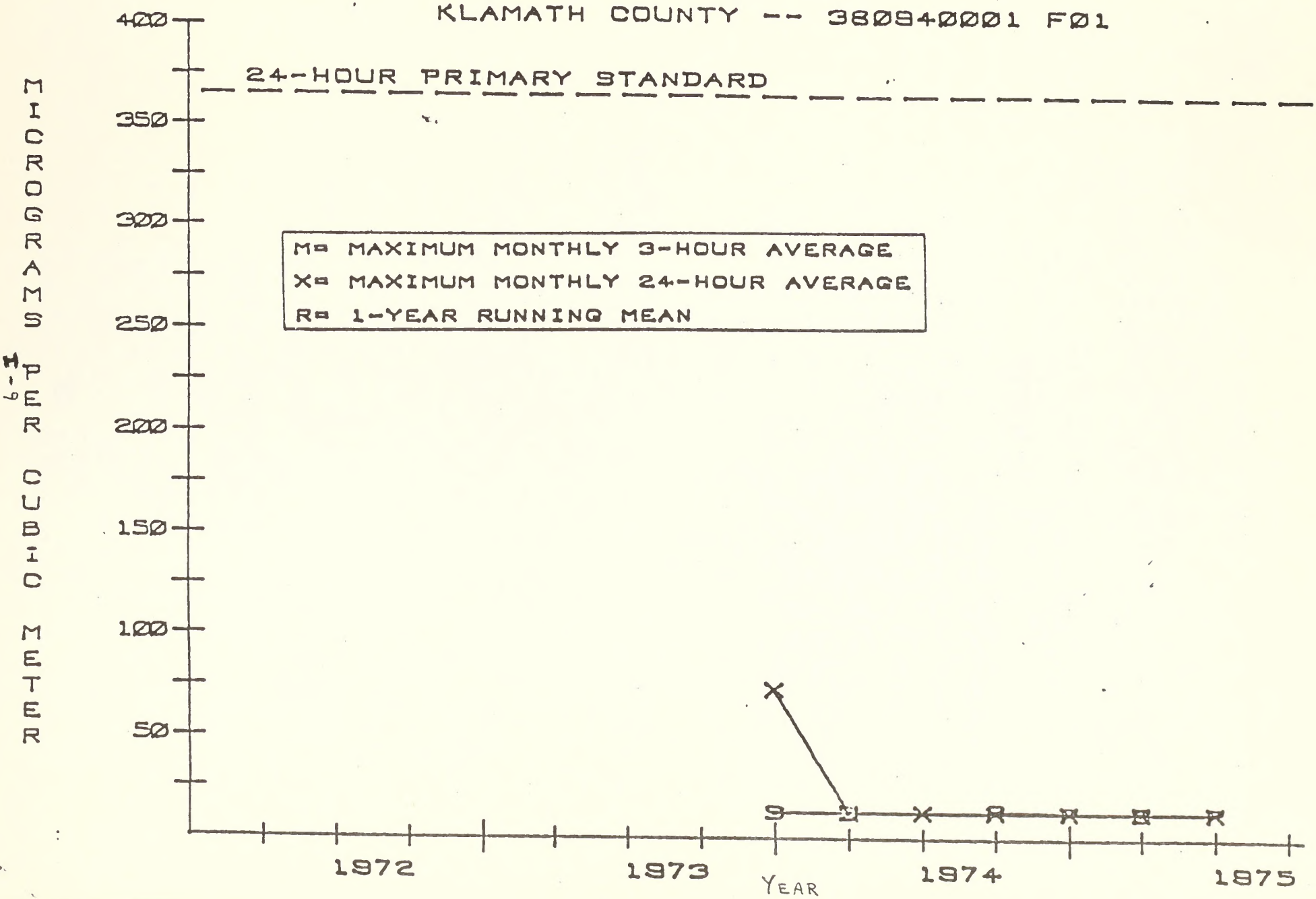
Sample Date	Sample Concentration mg/u^3	Mineral material	Combustion products	Biotic* material	Miscellaneous
1/11/74	67	55	21	14	10
4/5/74	193	48	19	18	15
4/11/74	45	60	16	12	12
4/17/74	181	59	16	13	12
4/23/74	153	58	14	15	13
9/14/74	66	59	12	14	15
10/8/74	171	54	15	14	17
11/13/74	198	42	13	30	15
30/75	230	58	17	14	11
Average percentages		54.8	15.9	16	13.3

* Includes a large percentage of diatom shells, probably wind entrained from diatomaceous earth deposits in the area.

TRENDS IN SULFUR DIOXIDE

KLAMATH FALLS -- FIRE DEPARTMENT

KLAMATH COUNTY -- 380940001 F01



APPENDIX II

SOILS

OR-SOILS-1 12/72
FILE CODE SOILS 12

SOIL INTERPRETATIONS FOR OREGON

U.S.D.A. SOIL CONSERVATION SERVICE

DATE: 7/74 JC FLOKE SERIES SOILS: 1. Floke - Olson association, 1 - 8% slopes

The Floke series consists of well-drained, very stony loam over clay and silty clay loam soils underlain by hardpans. These soils formed in materials weathered from basaltic flow breccia. They have 1 to 8 percent slopes and are on lava tablelands at elevations of 4800 to 6000 feet. The plant cover mainly is low sagebrush and bunchgrasses. Average annual precipitation is 8 to 10 inches, the average annual air temperature is 43° to 45°F., and the frost-free period is 10 to 50 days.

Typically, the surface layer is gray very stony loam about 3 inches thick. The subsoil is about 16 inches thick and has 3 parts. The upper part is brown clay about 5 inches thick. The middle part is yellowish-brown heavy, silty clay loam about 5 inches thick. The lower part is very pale-brown silty clay loam about 6 inches thick. An indurated, very stony and bouldery hardpan occurs at a depth of 19 inches. Depth to the hardpan ranges from 12 to 20 inches.

Permeability is slow. Effective rooting depth ranges from 12 to 20 inches. Runoff is rapid and the erosion hazard is severe. Available water capacity is 1½ to 4½ inches and the water supplying capacity is 6 to 8 inches.

Floke soils are used for range, wildlife habitat, and water supply. They occur on tablelands in south-central Oregon (D23).

(Classification: Abruptic Xerollic Durargids; clayey, montmorillenitic, frigid, shallow family.)

ESTIMATED SOIL PROPERTIES

DEPTH FROM SURFACE (in.)	CLASSIFICATION			COARSE FRACT. OVER 3 IN.	% OF MATERIAL PASSING SIEVE				LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (in/hr)	AVAIL. WATER CAP. (in/in)	SOIL REACTION (pH)1/	SHRINK SWELL POTENTIAL
	USDA 1/ TEXTURE	UNIFIED	AASHO		#4	#10	#40	#200						
0-3	Loam	SM,ML	A-4	0-15	70-95	65-90	55-85	40-70	Nonplastic		0.6-2.0	.13-.19	6.6-7.3	Low
3-19	Clay, silty clay loam	CH	A-7	0-15	70-95	65-90	60-90	50-85	40-85	30-35	.06-.20	.12-.22	6.6-8.4	High
19-40	Hardpan	---	---	---	---	---	---	---	---	---	<.06	---	---	---

DEPTH (in.)	CONDUCTIVITY (mmhos/cm)	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUPS	FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (ft.)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	HYDROLOGIC GROUP
0-3	0.4 — 3.0	High	Low	.49	1	--	None			>6			D
3-19	0.4 — 6.0	High	Low	.20									

CEMENTED PAN DEPTH (in.)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (in.)	BEDROCK HARDNESS	FROST ACTION	REMARKS
12-20	Hard	40-60+	Hard	Moderate	K factor for 0-3" depth reduced 2 classes for stoniness

SANITARY FACILITIES AND COMMUNITY DEVELOPMENT

USE	SOIL	RATING	RESTRICTIVE FEATURES
SEPTIC TANK ABSORPTION FIELDS	1	Severe	Cemented pan, stones, percolates slowly
SEWAGE LAGOONS	1	Severe	Cemented pan, stones
SANITARY LANDFILL (TRENCH)	1	Severe	Cemented pan, stones, too clayey
SANITARY LANDFILL (AREA)	1	Slight	
DAILY COVER FOR LANDFILL	1	Poor	Cobbles, stones, thin layer, too clayey
SHALLOW EXCAVATIONS	1	Severe	Cemented pan, cobbles, stones, too clayey
DWELLINGS WITHOUT BASEMENTS	1	Severe	Low strength, cemented pan, shrink-swell, cobbles, stones
DWELLINGS WITH BASEMENTS	1	Severe	Low strength, cemented pan, shrink-swell, cobbles, stones
SMALL COMMERCIAL BUILDINGS	1	Severe	Low strength, cemented pan, shrink-swell, cobbles, stones
LOCAL ROADS AND STREETS	1	Severe	Low strength, cemented pan, shrink-swell, cobbles, stones

SOURCE MATERIAL AND WATER MANAGEMENT

USE	SOIL	RATING	RESTRICTIVE FEATURES
ROADFILL	1	Poor	Borrow area damage, cobbles, stones, thin layer
SAND	1	Unsuited	Thin layer, excessive fines
GRAVEL	1	Unsuited	Thin layer, excessive fines
TOPSOIL	1	Poor	Borrow area damage, cobbles, stones, too clayey, thin layer
POND RESERVOIR AREA	1	Severe	Cemented pan
EMBANKMENTS DIKES AND LEVEES	1	Severe	Low strength, compressible, shrink-swell, cobbles, stones, thin layer
DRAINAGE	1		Not needed
IRRIGATION	1	Unsuited	Rooting depth, short growing season, stones
TERRACES AND DIVERSIONS	1		Not needed
GRASSED WATERWAYS	1		Not needed

CONTINUATION SHEET OR-SOILS-1 12/72 FLOKE SERIES

RECREATION

USE	SOIL	RATING	RESTRICTIVE FEATURES	USE	SOIL	RATING	RESTRICTIVE FEATURES
CAMP AREAS	1	Severe	Cobbles and stones	PLAYGROUNDS	1	Severe	Cobbles and stones, slope
PICNIC AREAS	1	Severe	Cobbles and stones	PATHS AND TRAILS	1	Severe	Cobbles and stones

CAPABILITY AND PREDICTED YIELDS - CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

SOIL	CAPABILITY														REMARKS
	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	
1	VIIs														

WOODLAND SUITABILITY

SOIL	POTENTIAL PRODUCTIVITY		WOOD SUIT. GROUP	MANAGEMENT PROBLEMS					NATIVE SPECIES
	SPECIES	SITE INDEX		EROSION HAZARD	EQUIPMENT LIMIT.	SEEDLING MORTALITY	WINDTHROW HAZARD	PLANT COMPET.	
	None								

WINDBREAKS

SOILS	SPECIES	HT. AGE 20	PERFOR-MANCE	SPECIES	HT. AGE 20	PERFOR-MANCE	SPECIES	HT. AGE 20	PERFOR-MANCE
	None								

WILDLIFE HABITAT SUITABILITY

SOIL	POTENTIAL FOR HABITAT ELEMENTS								POTENTIAL AS HABITAT FOR:			
	GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLAND WILDLIFE	WOODLAND WILDLIFE	WETLAND WILDLIFE	RANGELAND WILDLIFE
1 NIRR	Very poor	Very poor	Fair	---	Very poor	Fair	Poor	Very poor	---	---	Very poor	Fair

RANGELAND

RANGE SITE NAME	SOIL	KEY SPECIES AND % COVER	POTENTIAL YIELDS		NORMAL SEASON	
			TOTAL lb/Ac	USABLE Ac/AUM	GROWING	GRAZING
Rocky Terrace	1	Spiny hopsage 2 Low sagebrush 10 Bluebunch wheatgrass 15 Sandberg bluegrass 20 Webber ricegrass 5			4/15 - 7/1	5/15 - 12/1

FOOTNOTES

1/ Based on soil characterization laboratory data for Floke soils sampled in Lake Co., Oregon, 1968.

OR-SOILS-1 12/72
FILE CODE SOILS 12

SOIL INTERPRETATIONS FOR OREGON

U.S.D.A. SOIL CONSERVATION SERVICE

DATE: 7/74 JC

OLSON SERIES

SOILS:

1. Olson loam, 0 - 2% slopes
2. Floke - Olson association, 1 - 8% slopes

The Olson series consists of well-drained, loam over clay loam soils underlain by hardpans. These soils formed in sediments weathered from tuff and basalt. They have 0 to 8 percent slopes and are on terraces and tablelands at elevations of 4800 to 6000 feet. The plant cover mainly is big sagebrush, spiny hop sage, and bunchgrasses. Average annual precipitation is 8 to 10 inches, the average annual air temperature is 43° to 45°F., and the frost-free period is 10 to 50 days.

Typically, the surface layer is light brownish-gray loam about 6 inches thick. The subsoil is light brownish-gray and pale-brown clay loam about 9 inches thick. An indurated hardpan occurs at a depth of about 15 inches. Depth to the hardpan ranges from 12 to 20 inches.

Permeability is moderately slow. Effective rooting depth is 12 to 20 inches. Runoff is slow and the erosion hazard is slight. Available water capacity is 1½ to 4 inches and the water supplying capacity is about 7 to 9 inches.

Olson soils are used for range and wildlife habitat. They occur on tablelands in south-central Oregon (D23).

(Classification: Xerollic Durargids; loamy, mixed, frigid, shallow family.)

ESTIMATED SOIL PROPERTIES

DEPTH FROM SURFACE (in.)	CLASSIFICATION			COARSE FRACT. OVER 3 IN.	% OF MATERIAL PASSING SIEVE				LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (in/hr)	AVAIL. WATER CAP. (in/in)	SOIL REACTION (pH)	SHRINK SWELL POTENTIAL
	USDA TEXTURE	UNIFIED	AASHO		#4	#10	#40	#200						
0-6	Loam	GM, SM, ML	A-2, A-4	0	55-95	50-90	40-85	30-70	Nonplastic		0.6-2.0	.13-.19	6.6-7.3	Low
6-15	Clay loam	GC, CL	A-2, A-6	0	50-85	45-80	40-80	30-65	30-40	10-15	0.2-0.6	.15-.21	7.4-8.4	Moderate
15-40	Hardpan	--	--	--	--	--	--	--	--	--	<.06	--	--	--

DEPTH (in.)	CONDUCTIVITY (mmhos/cm)	CORROSIVITY		EROSION FACTORS		WIND EROD. GROUPS	FLOODING			HIGH WATER TABLE			HYDROLOGIC GROUP
		STEEL	CONCRETE	K	T		FREQUENCY	DURATION	MONTHS	DEPTH (ft.)	KIND	MONTHS	
0-6	-----	Low	Low	.32	1	---	None			>6			D
6-15	0.4 - 10	High	Low	.24									

CEMENTED PAN		BEDROCK		FROST ACTION	REMARKS
DEPTH (in.)	HARDNESS	DEPTH (in.)	HARDNESS		
12-20	Hard	40-60+	Hard	Moderate	

SANITARY FACILITIES AND COMMUNITY DEVELOPMENT

USE	SOIL	RATING	RESTRICTIVE FEATURES
SEPTIC TANK ABSORPTION FIELDS	1,2	Severe	Cemented pan, percolates slowly
SEWAGE LAGOONS	1,2	Moderate to severe	Cemented pan, slope
SANITARY LANDFILL (TRENCH)	1,2	Severe	Cemented pan
SANITARY LANDFILL (AREA)	1,2	Slight	
DAILY COVER FOR LANDFILL	1,2	Poor	Thin layer
SHALLOW EXCAVATIONS	1,2	Severe	Cemented pan
DWELLINGS WITHOUT BASEMENTS	1,2	Severe	Cemented pan
DWELLINGS WITH BASEMENTS	1,2	Severe	Cemented pan
SMALL COMMERCIAL BUILDINGS	1,2	Severe	Cemented pan
LOCAL ROADS AND STREETS	1,2	Severe	Cemented pan

SOURCE MATERIAL AND WATER MANAGEMENT

USE	SOIL	RATING	RESTRICTIVE FEATURES
ROADFILL	1,2	Poor	Borrow area damage, thin layer
SAND	1,2	Unsuited	Excessive fines, thin layer
GRAVEL	1,2	Poor	Excessive fines, thin layer
TOPSOIL	1,2	Poor	Borrow area damage, pebbles, thin layer
POND RESERVOIR AREA	1,2	Severe	Cemented pan, seepage
EMBANKMENTS DIKES AND LEVEES	1,2	Severe	Thin layer
DRAINAGE	1,2		Not needed
IRRIGATION	1,2	Poor	Droughty, rooting depth, short growing season
TERRACES AND DIVERSIONS	1,2		Not needed
GRASSED WATERWAYS	1,2		Not needed

CONTINUATION SHEET OR-SOILS-1 12/72 OLSON SERIES

RECREATION

USE	SOIL	RATING	RESTRICTIVE FEATURES	USE	SOIL	RATING	RESTRICTIVE FEATURES
CAMP AREAS	1,2	Slight		PLAYGROUNDS	1,2	Moderate to severe	Pebbles, slope
PICNIC AREAS	1,2	Slight		PATHS AND TRAILS	1,2	Slight	

CAPABILITY AND PREDICTED YIELDS - CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

SOIL	CAPABILITY														REMARKS
	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	
1,2	VIe														

WOODLAND SUITABILITY

SOIL	POTENTIAL PRODUCTIVITY		WOOD SUIT. GROUP	MANAGEMENT PROBLEMS					NATIVE SPECIES
	SPECIES	SITE INDEX		EROSION HAZARD	EQUIPMENT LIMIT.	SEEDLING MORTALITY	WINDTHROW HAZARD	PLANT COMPET.	
	None								

WINDBREAKS

SOILS	SPECIES	HT. AGE 20	PERFOR-MANCE	SPECIES	HT. AGE 20	PERFOR-MANCE	SPECIES	HT. AGE 20	PERFOR-MANCE
	None								

WILDLIFE HABITAT SUITABILITY

SOIL	POTENTIAL FOR HABITAT ELEMENTS								POTENTIAL AS HABITAT FOR:			
	GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLAND WILDLIFE	WOODLAND WILDLIFE	WETLAND WILDLIFE	RANGELAND WILDLIFE
1,2	Poor	Fair	Fair	—	Very poor	Fair	Very poor	Very poor	Fair	—	Very poor	Fair

RANGELAND

RANGE SITE NAME	SOIL	KEY SPECIES AND % COVER	POTENTIAL YIELDS		NORMAL SEASON	
			TOTAL lb/Ac	USABLE Ac/AUM	GROWING	GRAZING
Droughty Bottomland Fan	1	Big sagebrush 10 Thurber needlegrass 40 Webber ricegrass 10 Bluebunch wheatgrass 5			4/1 - 7/1	5/1 - 12/1
Semi-Desert Terrace	2	Big sagebrush 10 Bluebunch wheatgrass 25 Spiny hopsage 15			4/1 - 7/1	5/1 - 12/1
Arid Loamy Terrace	1	Big sagebrush 20 Bluebunch wheatgrass 40 Indian ricegrass 15			4/1 - 7/1	5/1 - 12/1

FOOTNOTES

APPENDIX III

ANIMAL AND PLANT SPECIES

APPENDIX

Partial List of Animals Known or Thought to Occur in the Proposed Geothermal Lease Area

MAMMALS

Name

Order Insectivora
- Family Soricidae
  - Merriams Shrew - Classed as rare in Oregon by Agric. Experiment Station 1972 (thought to occur in area)

Order Chiroptera
- Family Vespertilionidae
  - Pallid Bat
  - Silver-haired Bat
  - Hoary Bat
  - Big Brown Bat
  - Fringed Myotis
  - Hairy-winged Myotis
  - California Myotis
  - Small-footed Myotis
  - Yuma Myotis
  - Western Pipistrelle
- Family Leporidae
  - Pigmy Rabbit
  - Mountain Cottontail
  - Black-tailed Hare
  - White-tailed Hare

Order Rodentia
- Family Erethizontidae
  - Porcupine
- Family Sciuridae
  - Yellow-bellied Marmot
  - Townsend's Chipmunk
  - Least Chipmunk
  - Antelope Ground Squirrel
  - Townsend's Ground Squirrel
  - Richardson's Ground Squirrel

Family Geomyidae
Northern Pocket Gopher

Family Heteromyidae
Dark Kangaroo Mouse
Ord's Kangaroo Rat
Great Basin Pocket Mouse

Family Cricetidae
Western Harvest Mouse
Northern Grasshopper Mouse
Bushy-tailed Wood Rat
Desert Wood Rat
Canyon Mouse
Pinon Mouse
Deer Mouse
Sagebrush Vole

Family Muridae
House Mouse

Family Zapodidae
Western Jumping Mouse

Order Carnivora
Family Felidae
Bobcat

Family Canidae
Coyote

Family Mustelidae
Badger
Striped Skunk
Long-tailed Weasel

Family Procyonidae
Raccoon

Order Artiodactyla
Family Antilocapridae
Pronghorn Antelope

Family Cervidae
Rocky Mt. Mule Deer

BIRDS

From: Check list of the Birds of Oregon
by Gerard A. Bertrand & J. Michael Scott

Name	Status	Occurrence
Order Anseriformes		
Family Anatidae		
Canada Goose	Migrant	Uncommon
Mallard	Summer Resident	Common
Pintail	Migrant	Uncommon
Cinnamon Teal	Migrant	Uncommon
Order Falconiformes		
Family Cathartidae		
Turkey Vulture	Summer Resident	Common
Family Accipitridae		
Rough-legged Hawk	Winter Visitor	Uncommon
Golden Eagle	Resident	Common
Bald Eagle	Migrant	Uncommon
Marsh Hawk	Visitor	Uncommon
Family Falconidae		
Sparrow Hawk	Resident	Common
Prairie Falcon	Resident	Rare
Order Galliformes		
Family Tetraonidae		
Sage Grouse	Resident	Common
Family Phasianidae		
California Quail	Resident	Common
Order Charadriiformes		
Family Charadriidae		
Killdeer	Resident	Common
Long-billed Dowitcher	Summer Visitor	Uncommon
Order Columbiformes		
Family Columbidae		
Mourning Dove	Summer Resident	Common
Order Strigiformes		
Family Strigidae		
Great Horned Owl	Visitor	Uncommon
Pygmy Owl	Visitor	Uncommon
Burrowing Owl	Summer Resident	Uncommon

Name	Status	Occurrence
Order Caprimulgiformes		
Family Caprimulgidae		
Common Nighthawk	Summer Resident	Common
Order Apodiformes		
Family Trochilidae		
Black-chinned Hummingbird	Summer Visitor	Rare
Order Piciformes		
Family Picidae		
Red-shafted Flicker	Resident	Common
Order Passeriformes		
Family Tyrannidae		
Gray Flycatcher	Summer Resident	Common
Family Alaudidae		
Horned Lark	Resident	Common
Family Hirundinidae		
Violet-green Swallow	Summer Resident	Common
Barn Swallow	Summer Resident	Common
Cliff Swallow	Summer Resident	Common
Family Corvidae		
Black-billed Magpie	Resident	Common
Common Raven	Resident	Common
Pinon Jay	Resident	Common
Family Paridae		
Mountain Chickadee	Winter Resident	Uncommon
Family Mimidae		
Sage Thrasher	Summer Resident	Rare
Family Turdidae		
Robin	Summer Resident	Common
Mountain Bluebird	Resident	Common
Townsend's Solitair	Resident	Common
Family Motacillidae		
Water Pipit	Resident	Common
Family Laniidae		
Loggerhead Shrike	Resident	Common

Name	Status	Occurrence
Order Passeriformes (cond't)		
Family Sturnidae		
Starling	Resident	Common
Family Icteridae		
Western Meadowlark	Resident	Common
Red-wing Blackbird	Visitor	Uncommon
Brewers Blackbird	Resident	Common
Brown-headed Cowbird	Summer Resident	Common
Family Fringillidae		
House Finch	Visitor	Uncommon
Savannah Sparrow	Resident	Common
Sage Sparrow	Resident	Common
Lark Sparrow	Summer Resident	Uncommon
Black-Throated Sparrow	Summer Visitor	Uncommon
Chipping Sparrow	Summer Resident	Common
Brewers Sparrow	Summer Resident	Common

REPTILES

Order Caudata
- Family Ambystomatidae
  - Northern long-toed Salamander

Order Anura
- Family Pelobatidae
  - Great Basin spadefoot Toad
- Family Bufonidae
  - Western Toad
- Family Hylidae
  - Pacific Treefrog
- Family Ranidae
  - Bullfrog
  - Spotted From

Order Squamata
- Family Iguanidae
  - Leopard Lizard
  - Sagebrush Lizard
  - Great Basin fence Lizard

Name

Order Squamata (cond't)
- Family Iquanidae
  - Side-blotched Lizard
  - Short-horned Lizard
  - Desert horned Lizard
- Family Scincidae
  - Western Skink
- Family Colubridae
  - Desert striped Whipsnake
  - Great Basin gopher Snake
  - Common garter Snake
  - Desert night Snake
- Family Teiidae
  - Western Whiptail
- Family Viperidae
  - Western Rattlesnake

PARTIAL LIST OF PLANT SPECIES

Grasses

Blue Bunch Wheatgrass
Western Wheatgrass
Smooth Brome
Cheatgrass
Threadleaf Sedge
Saltgrass
Giant Wildrye
Idaho Fescue
Foxtail Barley
Junegrass
Indian Ricegrass
Timothy
Kentucky Bluegrass
Sandbergs Bluegrass
Squirreltail
Needle and Thread
Letterman Needlegrass
Crested Wheatgrass

Forbs

Western Yarrow
Wild Onion
Pussytoes
Milkweed
Aster Species
Milkvetch-Loco Species
Arrowleaf Balsamroot
Sego Lily
Indian Paintbrush
Lambsquarter - Goosefoot Species
Bull Thistle
Larkspur
Fleabane Species
Buckwheat
Gumweed
Sunflower
Peppergrass
Penstemon Species
Phlox
Russian Thistle
Dandelion
Deathcamas

PARTIAL LIST OF PLANT SPECIES (Cond't)

Shrubs

Low Sagebrush
Silver Sagebrush
Bud Sagebrush
Big Sagebrush
Rabbitbrush Species
Shrubby Buckwheat
Winterfat
Hopsage
Snakeweed
Picklepear
Greasewood
Shadscale

APPENDIX IV

COMBINED BIBLIOGRAPHY

APPENDIX

COMBINED BIBLIOGRAPHY

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APPENDIX V

Electrical Resistivity Survey And

Evaluation of the Glass Buttes Geothermal Anomay

State of Oregon

Department of Geology and Mineral
Industries

Open File Report 0-76-1

ELECTRICAL RESISTIVITY SURVEY

and

EVALUATION OF THE GLASS BUTTES GEOTHERMAL ANOMALY

LAKE COUNTY, OREGON

Donald A. Hull
Oregon Department of Geology and Mineral Industries

STATE OF OREGON

DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

OPEN-FILE REPORT 0-76-1

ABSTRACT

A dipole-dipole electrical resistivity survey was made at Glass Buttes, a silicic volcanic dome located along the Brothers fault zone in central Oregon, to evaluate the technique and to study the Glass Buttes geothermal anomaly. An a-spacing of 2,000 feet with separations between electrode pairs ranging from 2,000 to 12,000 feet and a frequency of 0.125 hertz were used. The survey revealed marked resistivity contrasts and outlined a broad area at depth underlain by material having a resistivity value interpreted to be less than 5 ohm meters. A near-surface layer with resistivity values exceeding 300 ohm meters generally coincides with the outline of the silicic volcanic rocks.

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NOT INCLUDED - ON FILE - PRINEVILLE DISTRICT

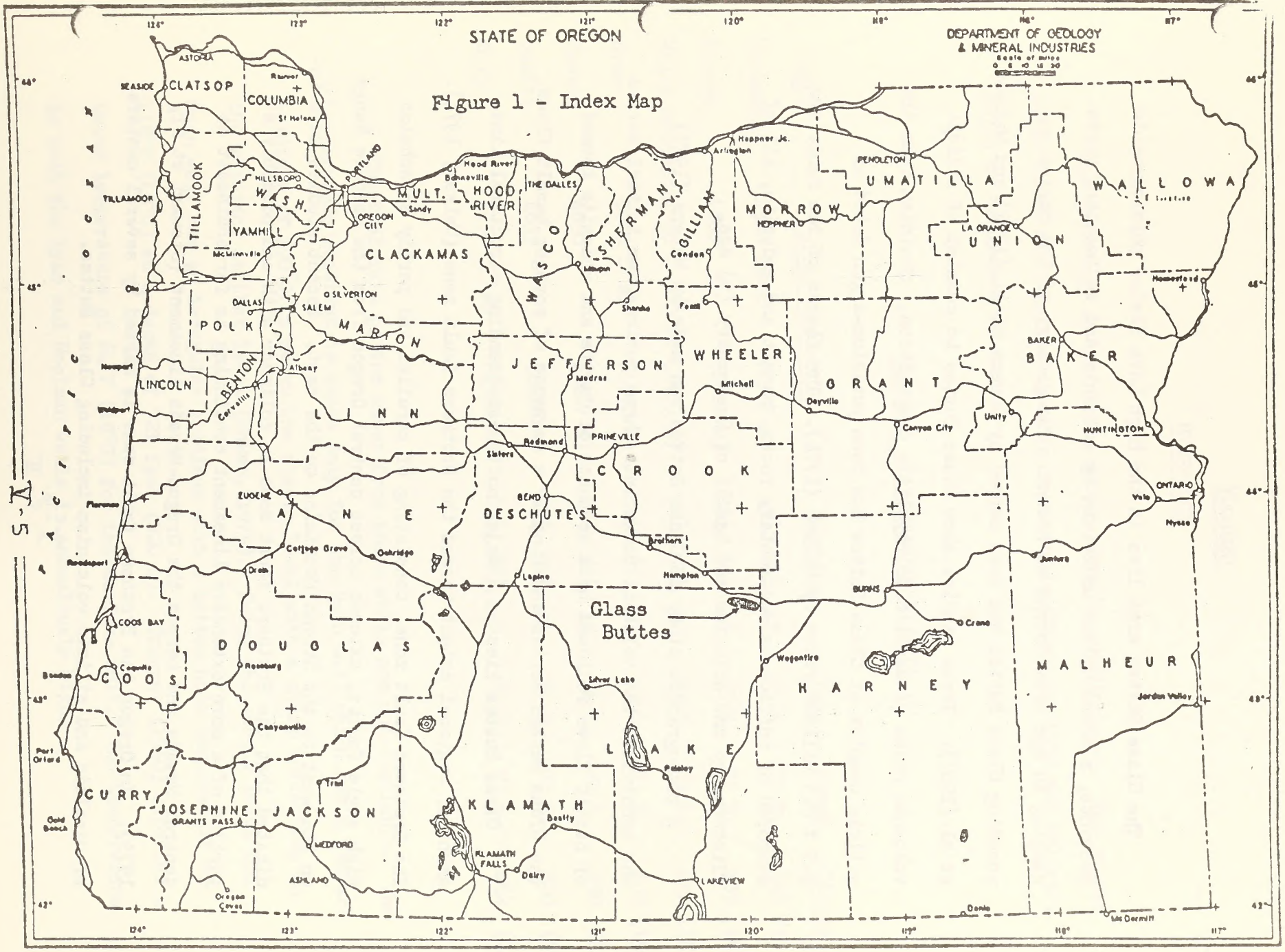
Appendix A - Phoenix Geophysics Inc., 1975, Report on a reconnaissance dipole-dipole resistivity survey in the Glass Buttes area, Lake County, Oregon: 8 p.

INTRODUCTION

Glass Buttes is a small west-northwest trending mountain range located in northeastern Lake County in Central Oregon (see figure 1). The range is 12 miles long in an N70W-S70E direction and 6 miles wide in a N30E-S30W direction. It lies in parts of T. 23 and 24 S., R. 22, 23 and 24 E. The nearest towns are Burns, which lies about 50 miles to the east, and Bend, which is 80 miles to the northwest. The area is accessible by U.S. Highway 20 which parallels the northern flank of the range.

ACKNOWLEDGEMENTS

The present study was undertaken in cooperation with the U.S. Energy Research and Development Administration's Los Alamos Scientific Laboratory located at Los Alamos, New Mexico. Drs. Donald W. Brown and Paul R. Kintzinger initiated and were involved in the planning of the geophysical program and provided guidance throughout. Mr. R.E. Corcoran, State Geologist, initially suggested the Glass Buttes area as a test site.


STATE OF OREGON
DEPARTMENT OF GEOLOGY & MINERAL INDUSTRIES
Scale of miles
0 5 10 15 20
Figure 1 - Index Map
PACIFIC OCEAN
CLATSOP
COLUMBIA
TILLAMOOK
WASH.
YAMHILL
MULT.
HOOD RIVER
WASCO
SHERMAN
GILLIAM
MORROW
UMATILLA
WALLOWA
UNION
CLACKAMAS
POLK
MARION
BENTON
LINCOLN
LINN
JEFFERSON
WHEELER
GRANT
BAKER
CROOK
LANE
DESCHUTES
DOUGLAS
COOS
CURRY
JOSEPHINE
JACKSON
KLAMATH
LAKE
HARNEY
MALHEUR
Glass Buttes
ASTORIA
SEASIDE
Rainier
St Helens
PORTLAND
TILLAMOOK
HILLSBORO
OREGON CITY
Sandy
McMinnville
Hood River
Bonneville
THE DALLES
Hoppner Jc.
Arlington
PENDLETON
HOPPNER
LA GRANDE
Condon
Moro
Shaniko
Fossil
Homestead
DALLAS
SALEM
SILVERTON
Newport
Waldport
Albany
Corvallis
Madras
Mitchell
Dayville
Canyon City
Unity
BAKER
HUNTINGTON
Redmond
Sisters
PRINEVILLE
EUGENE
BEND
Florence
Cottage Grove
Oakridge
Brothers
Hampton
Lapine
BURNS
Junction
ONTARIO
Vale
Nyssa
Reedsport
Drain
COOS BAY
Coquille
Bandon
Roseburg
Crane
Wagontire
Silver Lake
Canyonville
Jordan Valley
Port Orford
Trail
Paisley
Gold Beach
GRANTS PASS
MEDFORD
ASHLAND
KLAMATH FALLS
Bonanza
Dairy
LAKEVIEW
Oregon Caves
Denio
Ida Dermitt
124°
123°
122°
121°
120°
119°
118°
117°
46°
45°
44°
43°
42°

GEOLOGY

The Glass Buttes area lies in the High Lava Plains physiographic province, a broad upland underlain by volcanic and sedimentary rocks ranging in age from Eocene to Recent. The geology of the region surrounding Glass Buttes has been mapped by Greene et al. (1972) and Walker et al. (1967). These studies show Glass Buttes to consist of silicic volcanic rocks of dacitic to rhyolitic composition. Obsidian from the silicic complex at Glass Buttes has been potasium-argon dated at 4.9 ± 0.3 million years by Walker (1974). The flanks of the range are composed of tuffaceous sedimentary rocks, basalt and andesite, all of Pliocene age and alluvium and basalt of Quaternary (?) age.

A petrographic study of Glass Buttes was made by Waters (1927) who subdivided the volcanic rocks into three periods, an initial series of basalt flows followed by a sequence of dacite and andesite termed the Glass Buttes Series and finally a sequence of younger basalt flows.

Glass Buttes lies on a major northwest-trending structural lineament of regional extent termed the Brothers fault zone (Walker, 1974). The Brothers fault zone, consisting of parallel and partly en echelon high angle faults, extends across central Oregon from the Cascade Range on the west to the Steens Mountains on the east. Recent studies have indicated that the Brothers fault zone is colinear with and possibly a portion of a more extensive lineament continuing as far southeast as central Nevada and termed the Oregon-Nevada lineament (Stewart et al, 1975). In Oregon the Brothers fault zone is marked by several centers of basaltic and silicic volcanism including Glass Buttes.

HYDROLOGY

The hydrology in the Glass Buttes area is poorly known. The static water level has been measured in seven wells (Trauger, 1950 and Pulfrey, 1975) as tabulated below.

TABLE I - GROUNDWATER DATA

Well	Collar Elevation		Section	Twp.	Range	Static water
Woolman	4506 feet	(1373 m)	SE¼, SE¼, 13	23 S.	21 E.	240 ft. (73 m
Pausch	4600 "	(1402 m)	SE¼, SE¼, 32	23 S.	22 E.	533 (162)
Glass Buttes	4750 ± 100 ft	(1450 m)	SW¼, NE¼, 27	23 S.	23 E.	462 (141)
Ryan	4900 ± 100	(1490 m)	SW¼ (?), 27	23 S.	23 E.	509 (155)
Pausch	4650	(1417 m)	SE¼, NE¼, 18	24 S.	22 E.	290 (88)
DeWitt	4655	(1418 m)	SW¼, NW¼, 23	24 S.	22 E.	300 (91)
Bush	4950 ± 100	(1500 m)	SE¼, SE¼, 9	24 S.	23 E.	462 (141)

Chemical data on the water from these wells are not available. The temperature gradient is known only for the Ryan well which has a linear gradient of 190°C/Km above the static level with a sharp inflection in the gradient at that level (Bowen, 1975). Below the static level the Ryan well has an irregular gradient with a bottom hole temperature of 118°F (48°C) at a depth of 721 feet (220 m). Trauger (1950) reported a water temperature of 64°F (18°C) for the Woolman well. The temperature in both the Ryan and Woolman wells is anomalously high.

GEOPHYSICS

The electrical geophysical program described herein was undertaken (1) to obtain sub-surface geologic information over the thermal anomaly detected earlier (Bowen et al, 1975), (2) to test the dipole-dipole technique in a structurally complex area marked by lateral resistivity variations and (3) to develop conceptual ideas on the type of geothermal resource present at Glass Buttes. The geophysical program consisted of 28 line-miles of electrical resistivity surveying using a dipole-dipole array with colinear electrode pairs at an "a-spacing" of 2,000 feet (610 m), separations between electrode pairs varying from 2,000 feet (n of 1) to 12,000 feet (n of 6), and a frequency of 0.125 hertz. A single Schlumberger array was used for a depth sounding designed to evaluate the thickness of a near-surface higher resistivity unit. Survey lines were generally oriented north-south and N30E-S30S, i.e., roughly perpendicular to the structural trend of the area except for line 5 which was run sub-parallel to the predominant trend of faulting in the range.

The electrical surveying was performed by Phoenix Geophysics, Inc. of Tucson, Arizona. Further details of technique, data, and interpretation are provided in a report by Phoenix Geophysics attached as Appendix A.

GEOTHERMAL ENERGY POTENTIAL

The regional geothermal energy potential of central Oregon was discussed by Groh (1966) and later by Walker (1974). Groh noted the association of Quaternary volcanism and faulting and Walker described a progressive westward decrease in the age of silicic volcanism along the Brothers fault zone, a major regional lineament which crosses the Glass Buttes area. The Glass Buttes thermal anomaly was described briefly by Bowen et al (1975).

The Glass Buttes geothermal anomaly is poorly defined and the nature of the heat source and heat transfer mechanism are problematical. Geothermal systems are conceptually described as (1) hydrothermal convection systems (2) hot igneous systems or (3) conduction-dominated areas (White and Williams, 1975). Hydrothermal systems are further sub-divided into vapor-dominated and hot water dominated systems and the hot igneous systems may be either partly molten or hot dry rock systems. An understanding of the nature of a geothermal system is desirable for the design of efficient exploration to evaluate the system and ultimately is needed for reaching conclusions regarding the energy production potential of a system. Smith and Shaw (1975) included Glass Buttes in an evaluation of igneous-related geothermal systems of western United States. Based on estimates of age, magma volume and cooling rates, they concluded that Glass Buttes possibly had residual magmatic heat and noted that further study was needed.

There are no active hot springs or fumeroles in or near the Glass Buttes area possibly a reflection, in part, of a relatively deep water

table. Published temperature gradient data at Glass Buttes consists of a single hole located in the SW¼ (?), section 27, T. 23 S., R. 23 E. at the Glass Buttes mercury mine. A gradient of 190° C/km was measured in this well as described above.

Glass Buttes has been the site of past hydrothermal activity as evidenced by the presence at the east end of the range of pervasive rock alteration and low grade mercury mineralization (Brooks, 1963 and Ross, 1941). The alteration includes argillization and opalization of the silicic volcanic host rocks with cinnabar mineralization localized along northwest striking fractures and breccia zones which are parallel or sub-parallel the regional trend of the Brothers fault zone.. The low resistivity values (less than 5 ohm-meters) detected by the dipole-dipole surveying suggest that at least a portion of the Glass Buttes area could be underlain by a hot water system; however, the geophysical data are only permissive in this respect. If the high geothermal gradient in the Ryan well is due to convecting groundwater, the pattern of lower resistivity zones may be partly or wholly an expression of relatively low temperature fluid rather than any high temperature geothermal resource.

The zone of 30-60 ohm-meter resistivity values detected between stations 220 E and 300 E on line 5 could be a less permeable unit such as a shallow intrusive body extending to depth. Temperature gradient data are lacking for this resistivity unit but it represents a potential hot dry rock target which might be tested by shallow gradient drilling. The resistivity contrasts may be partly due to hydrothermal alteration as argillic alteration is both intensive and extensive in the eastern portion of the survey area.

CONCLUSIONS AND RECOMMENDATIONS

The present study indicates that the dipole-dipole technique can provide useful sub-surface information in evaluating a structurally complex volcanic area such as Glass Buttes.

The resistivity results suggest that the lithologic units at Glass Buttes are generally horizontal or sub-horizontal in the survey area with steep contacts between units. The contrast between the high resistivity surface layer and the much lower resistivity underlying material is likely due to a combination of geologic and hydrologic factors.

The existence of an abnormally high geothermal gradient at Glass Buttes may be due to (1) residual magmatic heat associated with igneous activity, (2) deep convection of groundwater perhaps along fault zones, or (3) a combination of these factors. If the heat source is magmatic, it is still not certain whether the geothermal system is a hot dry rock system, a hot water system, a vapor-dominated system, or a combination of these types. The limited geophysical data collected to date do not conclusively provide a basis for selecting among these alternatives. It is entirely possible that the anomalously high temperature gradient in the Ryan well is due to deep circulation of groundwater and may not represent significant geothermal energy potential.

Further investigation of the Glass Buttes geothermal anomaly will ideally require several approaches. Additional temperature gradient and heat flow data are needed to evaluate the resistivity variations detected during the present geophysical study. Geochemical geothermometry on subsurface fluids is desirable but interpretation of silica geothermometry

should take into consideration the opalite alteration associated with mercury mineralization and the widespread volcanic glass. Additional resistivity surveying is needed including more detailed evaluation of the near surface high resistivity layer. Detailed geologic mapping to constrain future geophysical interpretations is essential. Ultimately expensive deep drilling will be required to test the geothermal potential of the Glass Buttes area but additional geological, geochemical and geophysical work and shallow temperature gradient drilling are needed before the deeper drilling could be justified.

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APPENDIX VI

NOTICE OF INTENT TO CONDUCT

GEOTHERMAL RESOURCES EXPLORATION OPERATIONS

Form 3200-9

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

Notice Number

NOTICE OF INTENT TO CONDUCT GEOTHERMAL RESOURCE EXPLORATION OPERATIONS

Applicant(s)	Address *(include zip code)*
Operator	Address *(include zip code)*
Contractor(s)	Address *(include zip code)*

hereby apply for authorization to conduct exploration operations pursuant to the provisions of 43 CFR 3209 now or hereafter in force across and upon the following-described lands *(give description of lands by township, attach map or maps showing lands to be entered or affected)*

Type of operations to be conducted *(give brief description)*

Exploration operations will be conducted during the period *(date)* from to

Attached ☐ $ Surety bond ☐ Rider to Nationwide bond ☐ Rider to Statewide bond ☐ Bond to be furnished

Upon completion of exploration operations the undersigned agrees to notify the Authorized Officer that authorized exploration operations have been completed in conformance with the general and special terms and stipulations of the notice.

The undersigned hereby agrees (1) that he will not enter upon the described land until he has been informed in writing whether there are special stipulations applicable to his Notice of Intent, as to either time or method of operation or otherwise, and, if there are such stipulations, what those stipulations are, (2) that he will comply with those special stipulations, if any; and (3) that he will not enter upon the described lands until his entry has been approved by the Authorized Officer.

The undersigned agrees to be bound by the terms and conditions of this notice to conduct exploration operations when approved by the Authorized Officer.

The undersigned agrees that the filing of this *Notice* under the regulations (43 CFR Subpart 3209) does not vest or confer any preference right to a geothermal resources lease.

The undersigned agrees further that all exploration operations shall be conducted pursuant to the following terms and conditions:

1. Exploration operations shall be conducted in compliance with all Federal, State, and local laws, ordinances, or regulations which are applicable to the area of operations including, but not limited to, those pertaining to fire, sanitation, conservation, water pollution, fish, and game. All operations hereunder shall be conducted in a prudent manner.

2. Due care shall be exercised in protecting the described lands from damage. All necessary precautions shall be taken to avoid any damage other than normal wear and tear to improvements on the land including, but not limited to, gates, bridges, roads, culverts, cattle guards, fences, dams, dikes, vegetative cover, improvements, stock watering, and other facilities.

3. All drill holes shall be capped when not in use and appropriate procedures shall be taken to protect against hazards in order to protect the lives, safety, or property of other persons or of wildlife and livestock.

4. All vehicles shall be operated at a reasonable rate of speed and, in the operation of vehicles, due care shall be taken to safequard livestock and wildlife in the vicinity of operations. Existing roads and trails shall be used wherever possible. If new roads and trails are to be constructed, the Authorized Officer must be consulted prior to construction as to location and specifications. Reclamation and/or reseeding of new roads and trails shall be made as requested by the Authorized Officer.

5. Upon expiration, conclusion, or abandonment of operations conducted pursuant to this *Notice*, all equipment shall be removed from the land, and the land shall be restored as nearly as practicable to its original condition by such measures as the Authorized Officer may specify. All geophysical holes shall be safely plugged. The Authorized Officer shall be furnished a *Notice of Completion of Geothermal Resource Exploration Operations* (Form 3200–3) immediately upon cessation of all such operations and shall be further informed of the completion of reclamation work as soon as possible.

6. Location and depth of water sands encountered shall be disclosed to the Authorized Officer.

7. Operator shall contact the Authorized Officer prior to actual entry upon the land in order to be appraised of practices which shall be followed or avoided in the conduct of exploration operations pursuant to the terms of this *Notice* and applicable regulations. Operator will conduct no operations on the land unless the attached bond is in good standing.

8. Due care shall be exercised to avoid scarring or removal of ground vegetative cover.

9. All operations shall be conducted in such a manner to avoid (a) blockage of any drainage systems; (b) changing the character, or causing the pollution or siltation of rivers, streams, lakes, ponds, waterholes, seeps, and marshes; and (c) damaging fish and wildlife resources or habitat. Cuts or fills causing any of the above-mentioned problems will be repaired immediately in accordance with specifications of the Authorized Officer.

0. Vegetation shall not be disturbed within 300 feet of waters designated by the Authorized Officer, except at approved stream crossings.

1. Surface damage which induces soil movement and/or water pollution shall be subject to corrective action as required by the Authorized Officer.

2. Trails and campsites shall be kept clean. All garbage and foreign debris shall be eliminated as required by the Authorized Officer.

3. Operator shall protect all survey monuments, witness corners, reference monuments, and bearing trees against destruction, obliteration, or damage. He shall, at his expense reestablish damaged, destroyed, or obliterated monuments and corners, using a licensed surveyor, in accordance with Federal survey procedures. A record of the reestablishment shall be submitted to the Authorized Officer.

. Operator shall make every reasonable effort to prevent, control, or suppress any fires started by the operator, and to report, as soon as possible, to the Authorized Officer location and size of fires, and assistance needed to suppress such fires. Operator shall inform the Authorized Officer as soon as possible of all fires, regardless of location, noted, or suppressed by independent action.

15. No work shall be done within one-half mile of a developed recreation site without specific written authority from the Authorized Officer. Any travel within one-half mile of a recreation site shall be over existing roads or trails.

16. Use of explosives within one-half mile of designated waters is prohibited unless approved, in writing, by the Authorized Officer.

17. If operations conducted under the provisions of this *Notice* causes any damage to the surface of the national resource lands, such as, but not limited to, soil erosion, pollution of water, injury or destruction of livestock or wildlife, or littering, operator shall, within 48 hours, file with the Authorized Officer a map showing exact location of such damage and a written report containing operator's plans for correcting or minimizing damage, if possible.

18. Violation of, or failure to comply with any of these terms and conditions shall result in immediate shutdown of field operations until deficiency is corrected. Failure to correct deficiency within the time period allowed by the Authorized Officer shall result in forfeiture of bond.

19. The Bureau of Land Management reserves the right to close any area to operators in periods of fire danger or when irreparable damage to natural resources is imminent.

20. Contractor shall be liable for assuring compliance with all terms and conditions of this *Notice* and all actions of his designated operator, agents, and employees.

21. Where continuation of the operation will result in irreparable damage to the land and other natural resources this *Notice* will be immediately cancelled by the Authorized Officer.

2. Special Stipulations:

(Signature of Applicant)	(Date)	(Signature of Operator)	(Date)

e hereby agree to the special stipulations added and made a part of this *Notice* to conduct exploration operations.

(Signature of Holder of Notice)	(Date)	(Signature of Operator)	(Date)

ereby approve this *Notice* to conduct exploration operations.

(Signature of Authorized Officer)	(Title)	(Date)

GPO 851-317

APPENDIX VII

GEOTHERMAL RESOURCE LEASE

Form 3200-21

Form 3200-21
(May 1974)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

Serial Number

USGS – KGRA Determination:

GEOTHERMAL RESOURCES LEASE

☐ Competitive ☐ Noncompetitive

In consideration of the terms and conditions contained herein, and the grant made hereby, this lease is entered into by the UNITED STATES OF AMERICA (hereinafter called the "Lessor"), acting through the Bureau of Land Management (hereinafter called the "Bureau") of the Department of the Interior (hereinafter called the "Department"), and

(hereinafter called the "Lessee").

This lease is made pursuant to the Geothermal Steam Act of 1970 (84 Stat. 1566; 30 U.S.C. 1001–1025) (hereinafter called "the Act") to be effective on (hereinafter called the "effective date"). It is subject to all the provisions of the Act and to all the terms, conditions, and requirements of (a) all regulations promulgated by the Secretary of the Interior (hereinafter called "the Secretary") in existence upon the effective date, specifically including, but not limited to, 43 CFR Parts 3000 and 3200 and 30 CFR Parts 270 and 271, (b) all geothermal resources operational orders (hereinafter called "GRO orders") issued pursuant thereto, all of which are incorporated herein and by reference made a part hereof, and (c) any regulations hereafter issued by the Secretary (except those inconsistent with any specific provisions of this lease other than regulations incorporated herein by reference) all of which shall be, upon their effective date, incorporated herein and, by reference, made a part hereof.

Sec. 1. GRANT – The Lessor hereby grants and leases to the Lessee the exclusive right and privilege to drill for, extract, produce, remove, utilize, sell, and dispose of geothermal steam and associated geothermal resources, (hereinafter called "geothermal resources"), in or under the following described lands situated within the County of

State of

National Resource Lands	Acquired Lands
T. ; R. ; Meridian	T. ; R. ; Meridian
Total Area	Total Area

Containing acres (hereinafter called the "leased area" or "leased lands"), together with:

(a) The nonexclusive right to conduct within the leased area geological and geophysical exploration in accordance with applicable regulations; and

(b) The right to construct or erect and to use, operate, and maintain within the leased area, together with ingress and egress thereupon all wells, pumps, pipes, pipelines, buildings, plants, sumps, brine pits, reservoirs, tanks, waterworks, pumping stations, roads, electric power generating plants, transmission lines, industrial facilities, electric, telegraph or telephone lines, and such other works and structures and to use so much of the surface of the land as may be necessary or reasonably convenient for the production, utilization, and processing of geothermal resources or to the full enjoyment of the rights granted by this lease, subject to compliance with applicable laws and regulations; *Provided that*, although the use of the leased area for an electric power generating plant or transmission facilities or a commercial or industrial facility is authorized hereunder, the location of such facilities and the terms of occupancy therefor shall be under separate instruments issued under any applicable laws and regulations; and

(c) The nonexclusive right to drill potable water wells in accordance with state water laws within the leased area and to use the water produced therefrom for operations on the leased lands free of cost, provided that such drilling and development are conducted in accordance with procedures approved by the Supervisor of the Geological Survey (hereinafter called "Supervisor"); and

(d) The right to convert this lease to a mineral lease under the Mineral Leasing Act of February 25, 1920, as amended, and supplemented (30 U.S.C. 181–287) or under the Mineral Leasing Act for Acquired Lands (30 U.S.C. 351–359), whichever is appropriate, if the leasehold is primarily valuable for the production of one or more valuable by-products which are leasable under those statutes, and the lease is incapable of commercial production or utilization of geothermal steam: *Provided that*, an application is made therefor prior to the expiration of the lease extension by reason of by-product production as hereinafter provided, and subject to all the terms and conditions of said appropriate Acts. The Lessee is also granted the right to locate mineral deposits under the mining laws (30 U.S.C. 21–54), which would constitute by-products if commercial production or utilization of geothermal steam continued, but such a location to be valid must be completed within ninety (90) days after the termination of this lease. Any conversion of this lease to a mineral lease or a mining claim is contingent on the availability of such lands for this purpose at the time of the conversion. If the lands are withdrawn or acquired in aid of a function of any Federal Department or agency, the mineral lease or mining claim shall be subject to such additional terms and conditions as may be prescribed by such Department or agency for the purpose of making operations thereon consistent with the purposes for which these lands are administered; and

(e) The right, without the payment of royalties hereunder, to reinject into the leased lands geothermal resources and condensates to the extent that such resources and condensates are not utilized, but their reinjection is necessary for operations under this lease in the recovering or processing of geothermal resources. If the Lessee, pursuant to any approved plan, disposes of the unusable brine and produced waste products into underlying formations, he may do so without the payment of royalties.

Sec. 2. TERM

(a) This lease shall be for a primary term of ten (10) years from the effective date and so long thereafter as geothermal steam is produced or utilized in commercial quantities but shall in no event continue for more than forty (40) years after the end of the primary term. However, if at the end of that forty-year period geothermal steam is being produced or utilized in commercial quantities, and the leased lands are not needed for other purposes, the Lessee shall have a preferential right to a renewal of this lease for a second forty-year term in accordance with such terms and conditions as the Lessor deems appropriate.

(b) If actual drilling operations are commenced on leased lands or under an approved plan or agreement on and are being diligently prosecuted at the end of the primary term, this lease shall be extended for five (5) years and so long thereafter, but not more than thirty-five (35) years, as geothermal steam is produced or utilized in commercial quantities. If at the end of such extended term geothermal steam is being produced or utilized in commercial quantities, the Lessee shall have a preferential right to a renewal for a second term as in (a) above.

(c) If the Lessor determines at any time after the primary term that this lease is incapable of commercial production and utilization of geothermal steam, but one or more [illegible]able by-products are or can be produced in commercial [illegible]tities, this lease shall be extended for so long as such [illegible]oducts are produced in commercial quantities but not for [illegible] years from the date of such determination

Sec. 3. RENTALS AND ROYALTIES

(a) *Annual Rental* – For each lease year prior to the commencement of production of geothermal resources in commercial quantities on the leased lands, the Lessee shall pay the Lessor on or before the anniversary date of the lease a rental of $ for each acre or fraction thereof.

(b) *Escalating Rental* – Beginning with the sixth lease year and for each year thereafter until the lease year beginning on or after the commencement of production of geothermal resources in commercial quantitisa, the Lessee shall pay on or before the anniversary date of the lease an escalated rental in an amount per acre or fraction thereof equal to the rental per acre for the preceding year and an additional sum of one (1) dollar per acre or fraction thereof. If the lease is extended beyond ten (10) years for reasons other than the commencement of production of geothermal resources in commercial quantities, the rental for the eleventh year and for each lease year thereafter until the lease year beginning on or after the commencement of such production will be the amount of rental for the tenth lease year. If any expenditures are made in any lease year for diligent exploration on the leased lands in excess of the minimum required expenditures for that year, the excess may be credited against any rentals in excess of $ per acre or fraction thereof due the Lessor for that or any future year.

(c) *Royalty* – On or before the last day of the calendar month after the month of commencement of production in commercial quantities of geothermal resources and thereafter on a monthly basis, the Lessee shall pay to the Lessor:

(1) A royalty of percent on the amount or value of steam, or any other form of heat or other associated energy produced, processed, removed, sold, or utilized from this lease or reasonably susceptible to sale or utilization by the Lessee.

(2) A royalty of percent of the value of any by-product derived from production under this lease, produced, processed, removed, sold, or utilized from this lease or reasonably susceptible of sale or utilization by the Lessee, except that as to any by-product which is a mineral named in Sec. 1 of the Mineral Leasing Act of February 25, 1920, as amended, (30 U.S.C. 181), the rate of royalty for such mineral shall be the same as that provided in that statute and the maximum rate of royalty for such mineral shall not exceed the maximum royalty applicable under that statute.

(3) A royalty of percent of the value of commercially demineralized water which has been produced from the leased lands, and has been sold or utilized by the Lessee or is reasonably susceptible of sale or utilization by the Lessee. In no event shall the Lessee pay to the Lessor, for the lease year beginning on or after the commencement of production in commercial quantities on the leased lands or any subsequent lease year, a royalty of less than two (2) dollars per acre or fraction thereof. If royalty paid on production during the lease year has not satisfied this requirement, the Lessee shall pay the difference on or before the expiration date of the lease year for which it is paid.

(d) *Waiver and Suspension of Rental and Royalties* – Rentals or royalties may be waived, suspended, or reduced pursuant to the applicable regulations on the entire leasehold or any portion thereof in the interest of conservation or for the purpose of encouraging the greatest ultimate recovery of geothermal resources if the Lessor determines that it is necessary to do so to promote such development, or because the lease cannot be successfully operated under the terms fixed herein.

(e) *Undivided Fractional Interests* – Where the interest of the Lessor in the geothermal resources underlying any tract or tracts described in Sec. 1 is an undivided fractional interest, the rentals and royalties payable on account of each such tract shall be in the same proportion to the rentals and royalties provided in this lease as the individual fractional interest of the Lessor in the geothermal resources underlying such tract is to the full fee interest.

(f) *Readjustments* – Rentals and royalties hereunder may be readjusted in accordance with the Act and regulations to rates not in excess of the rates provided therein, and at not less than twenty (20) year intervals beginning thirty-five (35) years after the date geothermal steam is produced from the lease as determined by the Supervisor.

Sec. 4. PAYMENTS – It is expressly understood that the Secretary may establish the values and minimum values of geothermal resources to compute royalties in accordance with the applicable regulations. Unless otherwise directed by the Secretary, all payments to the Lessor will be made as required by the regulations. If there is no well on the leased lands capable of producing geothermal resources in commercial quantities, the failure to pay rental on or before the anniversary date shall cause the lease to terminate by operation of law except as provided by Sec. 3244.2 of the regulations. If the time for payment falls on a day on which the proper office to receive payment is closed, payment shall be deemed to be made on time if made on the next official working day.

Sec. 5. BONDS – The Lessee shall file with the Authorized Officer of the Bureau (hereinafter called the "Authorized Officer") shall maintain at all times the bonds required under the regulations to be furnished as a condition to the issuance of this lease or prior to entry on the leased lands in the amounts established by the Lessor and to furnish such additional bonds or security as may be required by the Lessor upon entry on the lands or after operations or production have begun.

Sec. 6. WELLS

(a) The Lessee shall drill and produce all wells necessary to protect the leased land from drainage by operations on lands not the property of the Lessor, or other lands of the Lessor leased at a lower royalty rate, or on lands as to which royalties and rentals are paid into different funds from those into which royalties under this lease are paid. However, in lieu of any part of such drilling and production, with the consent of the Supervisor, the Lessee may compensate the Lessor in full each month for the estimated loss of royalty through drainage in the amount determined by said Supervisor.

(b) At the Lessee's election, and with the approval of the Supervisor, the Lessee shall drill and produce other wells in conformity with any system of well spacing or production allotments affecting the field or area in which the leased lands are situated, which is authorized by applicable law.

(c) After due notice in writing, the Lessee shall diligently drill and produce such wells as the Supervisor shall require so that the leased lands may be properly and timely developed and for the production of geothermal steam and its by-products, including commercially demineralized water for beneficial uses in accordance with applicable state laws. However, the Supervisor may waive or modify the requirements of this subparagraph (c) in the interest of conservation of natural resources or for economic feasibility or other reasons satisfactory to him. If the products or by-products of geothermal production from wells drilled on this lease are susceptible of producing commercially demineralized water for beneficial uses, and a program therefor is not initiated with due diligence, the Lessor may at its option elect to take such products or by-products and the Lessee shall deliver all or any portion thereof to the Lessor at any point in the Lessee's geothermal gathering or disposal system without cost to the Lessee, if the Lessee's activities, under the lease, would not be impaired and such delivery would otherwise be consistent with field and operational requirements. The retention of this option by the Lessor shall in no way relieve the Lessee from the duty of producing commercially demineralized water where required to do so by the Lessor, except when the option is being exercised and then only with respect to wells where it is being exercised, or limit the Lessor's right to take any action under Sec. 25 to enforce that requirement.

Sec. 7. INSPECTION – The Lessee shall keep open at all reasonable times for the inspection of any duly authorized representative of the Lessor the leased lands and all wells, improvements, machinery, and fixtures thereon and all production reports, maps, records, books, and accounts relative to operations under the lease, and well logs, surveys, or investigations of the leased lands.

Sec. 8. CONDUCT OF OPERATIONS – The Lessee shall conduct all operations under this lease in a workmanlike manner and in accordance with all applicable statutes, regulations, and GRO orders, and all other appropriate directives of the Lessor to prevent bodily injury, danger to life or health, or property damage, and to avoid the waste of resources, and shall comply with all requirements which are set forth in 43 CFR Group 3200, including, but not limited to, Subpart 3204, or which may be prescribed by the Lessor pursuant to the regulations, and with the special stipulations which are attached to the lease, all of which are specifically incorporated into this lease. A breach of any term of this lease, including the stipulations attached hereto, will be subject to all the provisions of this lease with respect to remedies in case of default. Where any stipulation is inconsistent with a regular provision of this lease, the stipulation shall govern.

Sec. 9. INDEMNIFICATION

(a) The Lessee shall be liable to the Lessor for any damage suffered by the Lessor in any way arising from or connected with the Lessee's activities and operations conducted pursuant to this lease, except where damage is caused by employees of the Lessor acting within the scope of their authority.

(b) The Lessee shall indemnify and hold harmless the Lessor from all claims arising from or connected with the Lessee's activities and operations under this lease.

(c) In any case where liability without fault is imposed on the Lessee pursuant to this section, and the damages involved were caused by the action of a third party, the rules of subrogation shall apply in accordance with the law of the jurisdiction where the damage occurred.

Sec. 10. CONTRACTS FOR SALE OR DISPOSAL OF PRODUCTS – The Lessee shall file with the Supervisor not later than thirty (30) days after the effective date thereof any contract, or evidence of other arrangement for the sale or disposal of geothermal resources.

Sec. 11. ASSIGNMENT OF LEASE OR INTEREST THEREIN – Within ninety (90) days from the date of execution thereof, the Lessee shall file for approval by the Authorized Officer any instruments of transfer made of this lease or of any interest therein, including assignments of record title and working or other interests.

Sec. 12. REPORTS AND OTHER INFORMATION – At such times and in such form as the Lessor may prescribe, the Lessee shall comply with all reporting requirements of the geothermal resources leasing, operating, and unit regulations and shall submit quarterly reports containing the data which it has collected through the monitoring of air, land, and water quality and all other data pertaining to the effect on the environment by operations under the lease. The Lessee shall also comply with such other reporting requirements as may be imposed by the Authorized Officer or the Supervisor. The Lessor may release to the general public any reports, maps, or other information submitted by the Lessee except geologic and geophysical interpretations, maps, or data subject to 30 CFR 270.79 or unless the Lessee shall designate that information as proprietary and the Supervisor or the Authorized Officer shall approve that designation.

Sec. 13. DILIGENT EXPLORATION – In the manner required by the regulations, the Lessee shall diligently explore the leased lands for geothermal resources until there is production in commercial quantities applicable to this lease. After the fifth year of the primary term the Lessee shall make at least

the minimum expenditures required to qualify the operations on the leased lands as diligent exploration under the regulations.

Sec. 14. PROTECTION OF THE ENVIRONMENT (LAND, AIR AND WATER) AND IMPROVEMENTS – The Lessee shall take all mitigating actions required by the Lessor to prevent: (a) soil erosion or damage to crops or other vegetative cover on Federal or non-Federal lands in the vicinity; (b) the pollution of land, air, or water; (c) land subsidence, seismic activity, or noise emissions; (d) damage to aesthetic and recreational values; (e) damage to fish or wildlife or their habitats; (f) damage to or removal of improvements owned by the United States or other parties; or (g) damage to or destruction or loss of fossils, historic or prehistoric ruins, or artifacts. Prior to the termination of bond liability or at any other time when required and to the extent deemed necessary by the Lessor, the Lessee shall reclaim all surface disturbances as required, remove or cover all debris or solid waste, and, so far as possible, repair the offsite and onsite damage caused by his activity or activities incidental thereto, and return access roads or trails and the leased lands to an acceptable condition including the removal of structures, if required. The Supervisor or the Authorized Officer shall prescribe the steps to be taken by Lessee to protect the surface and the environment and for the restoration of the leased lands and other lands affected by operations on the leased lands and improvements thereon, whether or not the improvements are owned by the United States. Timber or mineral materials may be obtained only on terms and conditions imposed by the Authorized Officer.

Sec. 15. WASTE – The Lessee shall use all reasonable precautions to prevent waste of natural resources and energy, including geothermal resources, or of any minerals, and to prevent the communication of water or brine zones with any oil, gas, fresh water, or other gas or water bearing formations or zones which would threaten destruction or damage to such deposits. The Lessee shall monitor noise, air, and water quality conditions in accordance with any orders of the Supervisor.

Sec. 16. MEASUREMENTS – The Lessee shall gauge or otherwise measure all production, sales, or utilization of geothermal resources and shall record the same accurately in records as required by the Supervisor. Reports on production, sales, or utilization of geothermal resources shall be submitted in accordance with the terms of this lease and the regulations.

Sec. 17. RESERVATIONS TO LESSOR – All rights in the leased area not granted to the Lessee by this lease are hereby reserved to the Lessor. Without limiting the generality of the foregoing such reserved rights include:

(a) *Disposal* – The right to sell or otherwise dispose of the surface of the leased lands or any resource in the leased lands under existing laws, or laws hereafter enacted, subject to the rights of the Lessee under this lease;

(b) *Rights-of-way* – The right to authorize geological and geophysical explorations on the leased lands which do not interfere with or endanger actual operations under this lease, and the right to grant such easements or rights-of-way for joint or several use upon, through or in the leased area for steam lines and other public or private purposes which do not interfere with or endanger actual operations or facilities constructed under this lease;

(c) *Mineral Rights* – The ownership of and the right to extract oil, hydrocarbon gas, and helium from all geothermal steam and associated geothermal resources produced from the leased lands;

(d) *Casing* – The right to acquire the well and casing at the fair market value of the casing where the Lessee finds only potable water, and such water is not required in lease operations; and

(e) *Measurements* – The right to measure geothermal resources and to sample any production thereof.

Sec. 18. ANTIQUITIES AND OBJECTS OF HISTORIC VALUE – The Lessee shall immediately bring to the attention of the Authorized Officer any antiquities or other objects of historic or scientific interest, including but not limited to historic or prehistoric ruins, fossils, or artifacts discovered as a result of operations under this lease, and shall leave such discoveries intact. Failure to comply with any of the terms and conditions imposed by the Authorized Officer with regard to the preservation of antiquities may constitute a violation of the Antiquities Act (16 U.S.C. 431-433). Prior to operations, the Lessee shall furnish to the Authorized Officer a certified statement that either no archaeological values exist or that they may exist on the leased lands to the best of the of the Lessee's knowledge and belief and that they might be impaired by geothermal operations. If the Lessee furnishes a statement that archaeological values may exist where the land is to be disturbed or occupied, the Lessee will engage a qualified archaeologist, acceptable to the Authorized Officer, to survey and salvage, in advance of any operations, such archaeological values on the lands involved. The responsibility for the cost for the certificate, survey, and salvage will be borne by the Lessee, and such salvaged property shall remain the property of the Lessor or the surface owner.

See Reverse Side for Sec. 18

Sec. 19. DIRECTIONAL DRILLING – A directional well drilled under the leased area from a surface location on nearby land not covered by the lease shall be deemed to have the same effect for all purposes of this lease as a well drilled from a surface location on the leased area. In such circumstances, drilling shall be considered to have been commenced on the nearby land for the purposes of this lease, and production of geothermal resources from the leased area through any directional well located on nearby land, or drilling or reworking of any such directional well shall be considered production or drilling or reworking operations (as the case may be) on the leased area for all purposes of this lease. Nothing contained in this section shall be construed as granting to the Lessee any right in any land outside the leased area.

Sec. 20. OVERRIDING ROYALTIES – The Lessee shall not create overriding royalties of less than one-quarter (1/4) of one percent of the value of output nor in excess of 50 percent of the rate of royalty due to the Lessor specified in Sec. 3 of this lease except as otherwise authorized by the regulations. The Lessee expressly agrees that the creation of any overriding royalty which does not provide for a prorated reduction of all overriding royalties so that the aggregate rate of royalties does not exceed the maximum rate permissible under this section, or the failure to suspend an overriding royalty during any period when the royalties due to the Lessor have been suspended pursuant to the terms of this lease, shall constitute a violation of the lease terms.

Sec. 21. READJUSTMENT OF TERMS AND CONDITIONS – The terms and conditions of this lease other than those related to rentals and royalties may be readjusted in accordance with the Act at not less than ten-year intervals beginning ten (10) years after the date geothermal steam is produced from the leased premises as determined by the Supervisor.

Sec. 22. COOPERATIVE OR UNIT PLAN – The Lessee agrees that it will on its own, or at the request of the Lessor where it is determined to be necessary for the conservation of the resource or to prevent the waste of the resource, subscribe to and operate under any reasonable cooperative or unit plan for the development and operation of the area, field, or pool, or part thereof embracing the lands subject to this lease as the Secretary may determine to be practicable and necessary or advisable in the interest of conservation. In the event the leased lands are included within a unit, the terms of this lease shall be deemed to be modified to conform to such unit agreement. Where any provision of a cooperative or unit plan of development which has been approved by the Secretary, and which by its terms affects the leased area or any part thereof, is inconsistent with a provision of this lease, the provisions of such cooperative or unit plan shall govern.

Sec. 23. RELINQUISHMENT OF LEASE – The Lessee may relinquish this entire lease or any officially designated subdivision of the leased area in accordance with the regulations by filing in the proper BLM office a written relinquishment, in triplicate, which shall be effective as of the date of filing. No relinquishment of this lease or any portion of the leased area shall relieve the Lessee or its surety from any liability for breach of any obligation of this lease, including the obligation to make payment of all accrued rentals and royalties and to place all wells in the leased lands to be relinquished in condition for suspension or abandonment, and to protect or restore substantially the surface or subsurface resources in a manner satisfactory to the Lessor.

Sec. 24. REMOVAL OF PROPERTY ON TERMINATION OR EXPIRATION OF LEASE

(a) Upon the termination or expiration of this lease in whole or in part, or the relinquishment of the lease in whole or in part, as herein provided, the Lessee shall within a period of ninety (90) days (or such longer period as the Supervisor may authorize because of adverse climatic conditions) thereafter remove from the leased lands, no longer subject to the lease all structures, machinery, equipment, tools, and materials in accordance with applicable regulations and orders of the Supervisor. However, the Lessee shall, for a period of not more than six (6) months, continue to maintain any such property needed in the relinquished area, as determined by the Supervisor, for producing wells or for drilling or producing geothermal resources on other leases.

(b) Any structures, machinery, equipment, tools, appliances, and materials, subject to removal by the Lessee, as provided above, which are allowed to remain on the leased lands shall become the property of the Lessor on expiration of the 90-day period or any extension of that period which may be granted by the Supervisor. If the Supervisor directs the Lessee to remove such property, the Lessee shall do so at its own expense, or if it fails to do so within a reasonable period, the Lessor may do so at the Lessee's expense.

Sec. 25. REMEDIES IN CASE OF DEFAULT

(a) Whenever the Lessee fails to comply with any of the provisions of the Act, or the terms and stipulations of this lease, or of the regulations issued under the Act, or of any order issued pursuant to those regulations, and that default shall continue for a period of thirty (30) days after service of notice by the Lessor, the Lessor may (1) suspend operations until the requested action is taken to correct the noncompliance, or (2) cancel the lease in accordance with Sec. 12 of the Act (30 U.S.C. 1011). However, the 30-day notice provision applicable to this lease under Sec. 12 of the Act shall also apply as a prerequisite to the institution of any legal proceedings by the Lessor to cancel this lease while it is in a producing status. Nothing in this subsection shall be construed to apply to, or require any notice with respect to any legal action instituted by the Lessor other than an action to cancel the lease pursuant to Sec. 12 of the Act.

(b) Whenever the Lessee fails to comply with any of the provisions of the Act, or of this lease, or the regulations, or of any GRO Orders, or other orders, and immediate action is required, the Lessor without waiting for action by the Lessee may enter on the leased lands and take such measures as it may deem necessary to correct the failure, including a suspension of operations or production, all at the expense of the Lessee.

(c) A waiver of any particular violation of the provisions of the Act, or of this lease, or of any regulations promulgated by the Secretary under the Act, shall not prevent the cancellation of this lease or the exercise of any other remedy or remedies under paragraphs (a) and (b) of this section by reason of any other such violation, or for the same violation occuring at any other time.

(d) Nothing herein shall limit or affect the Lessee's right to a hearing and appeal as provided in Sec. 12 of the

Act and in the regulations promulgated thereunder.

(e) Upon cancellation, the Lessee shall remove all property in accordance with Sec. 24 hereof, and shall restore the leased lands in a manner acceptable to the Lessor or as may be otherwise required by the Lessor.

Sec. 26. HEIRS AND SUCCESSORS IN INTEREST – Each obligation hereunder shall extend to and be binding upon, and every benefit hereof shall inure to, the heirs, executors, administrators, successors, or assigns, of the respective parties hereto.

Sec. 27. UNLAWFUL INTEREST – No Member of, or Delegate to Congress, or Resident Commissioner, after his election or appointment, either before or after he has qualified, and during his continuance in office, and no officer, agent, or employee of the Department shall be admitted to any share or part in this lease or derive any benefit that may arise therefrom; and the provisions of Sec. 3741 of the Revised Statutes (41 U.S.C. Sec. 22), as amended, and Sections 431, 432, and 433 of Title 18 of the United States Code, relating to contracts made or entered into, or accepted by or on behalf of the United States, form a part of this lease so far as the same may be applicable.

Sec. 28. MONOPOLY AND FAIR PRICES – The Lessor reserves full power and authority to protect the public interest by promulgating and enforcing all orders necessary to insure the sale of the production from the leased lands at reasonable prices, to prevent monopoly, and to safeguard the public interest.

Sec. 29. EQUAL OPPORTUNITY CLAUSE – The Lessee agrees that, during the performance of this contract:

(1) The Lessee will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Lessee will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer, recruitment or recruitment advertising, layoff or termination, rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Lessee agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the Lessor setting forth the provisions of this Equal Opportunity clause.

(2) The Lessee will, in all solicitations or advertisements for employees placed by or on behalf of the Lessee, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.

(3) The Lessee will send to each labor union or representative of workers with which Lessee has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the Lessor, advising the labor union or workers' representative of the Lessee's commitments under this Equal Opportunity clause, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The Lessee will comply with all provisions of Executive Order No. 11246 of September 24, 1965, as amended, and of the rules, regulations, and relevant orders of the Secretary of Labor.

(5) The Lessee will furnish all information and reports required by Executive Order No. 11246 of September 24, 1965, as amended, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to its books, records, and accounts by the Secretary of the Interior and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the Lessee's noncompliance with the Equal Opportunity clause of this lease or with any of said rules, regulations, or orders, this lease may be canceled, terminated or suspended in whole or in part and the Lessee may be declared ineligible for further Federal Government contracts or leases in accordance with procedures authorized in Executive Order No. 11246 of September 24, 1965, as amended, and such other sanctions as may be imposed and remedies invoked as provided in Executive Order No. 11246 of September 24, 1965, as amended, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(7) The Lessee will include the provisions of Paragraphs (1) through (7) of this Section (29) in every contract, subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No. 11246 of September 24, 1965, as amended, so that such provisions will be binding upon each contractor, subcontractor, or subcontract, or purchase order as the Secretary may direct as a means of enforcing such provisions including sanctions for noncompliance; *provided, however,* that in the event the Lessee becomes involved in, or is threatened with, litigation with a contractor, subcontractor, or vendor as a result of such direction by the Secretary, the Lessee may request the Lessor to enter into such litigation to protect the interests of the Lessor.

Sec. 30. CERTIFICATION OF NONSEGREGATED FACILITIES – By entering into this lease, the Lessee certifies that it does not and will not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not and will not permit its employees to perform their services at any location, under its control, where segregated facilities are maintained. The Lessee agrees that a breach of this certification is a violation of the Equal Opportunity clause of this lease. As used in this certification, the term "segregated facilities" means, but is not limited to, any waiting rooms, work areas, rest rooms and wash rooms, or restaurants or other eating areas, time clocks, or locker rooms, and other storage or dressing rooms, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive, or are in fact segregated on the basis of race, color, religion, or national origin because of habit, local custom, or otherwise. Lessee further agrees that (except where it has obtained identical certifications from proposed contractors and subcontractors for specific time periods) it will obtain identical certifications from proposed contractors and subcontractors prior to the award of contracts or subcontracts exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause; that it will retain such certifications in its files; and that it will forward the following certification to such proposed contractors and subcontractors (except where the proposed contractor or subcontractor has submitted identical certifications for specific time periods); it will notify prospective contractors and subcontractors of requirement for certification of nonsegregated facilities. A Certification of Nonsegregated Facilities, as required by the May 9, 1967 Order (32 F.R. 7439, May 19, 1967) on Elimination of Segregated Facilities, by the Secretary of Labor, must be submitted prior to the award of a contract or subcontract exceeding $10,000 which is not exempt from the provisions of the Equal Opportunity clause. The certification may be submitted either for each contract and subcontract or for all contracts and subcontracts during a period (i.e., quarterly, semiannually, or annually).

Sec. 18 ANTIQUITIES AND OBJECTS OF HISTORIC VALUE

Prior to any operations under this lease, the Lessee will engage a qualified archeologist, acceptable to the Authorized Officer, to make an archeological survey of the land to be disturbed or occupied. A certified statement, signed by the qualified archeologist, setting out the steps taken in the survey and the findings thereof as to the existence of antiquities or other objects of historic or scientific interest, shall be submitted to the Authorized Officer. If the statement indicates the existence of such objects which might be disturbed by operations under this lease, the Lessee shall take such steps as may be required by the Authorized Officer, including archeological salvage. The responsibility for the cost for the certificate, survey, and salvage will be borne by the Lessee, and such salvage property shall remain the property of the Lessor or the surface owner.

The Lessee shall immediately bring to the attention of the Authorized Officer any antiquities or other objects of historic or scientific value of interest, including but not limited to historic or prehistoric ruins, fossils, or artifacts discovered as a result of operations under this lease, and shall leave such discoveries intact. Failure to comply with any of the terms and conditions imposed by the Authorized Officer with regard to the preservation of antiquities may constitute a violation of the Antiquities Act (16 U.S.C. 431-433).

In witness whereof the parties have executed this lease.

Lessee:

THE UNITED STATES OF AMERICA, Lessor:

By _____

(Signature of Lessee) (Authorized Officer)

(Signature of Lessee) (Title)

SEAL (Date) (Date)

GPO 853-471

APPENDIX VIII

GEOTHERMAL RESOURCES OPERATIONAL ORDERS

GEOTHERMAL RESOURCES
OPERATIONAL ORDERS

Issued under the Geothermal Steam Act of 1970

GRO Order 1. Exploratory Operations
GRO Order 2. Drilling, Completion and Spacing of Geothermal Wells
GRO Order 3. Plugging and Abandonment of Wells
GRO Order 4. General Environmental Protection Requirements

United States Department of Interior
Geological Survey
Conservation Division
Office of the Area Geothermal Supervisor

January 1976

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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CONSERVATION DIVISION

GEOTHERMAL RESOURCES OPERATIONAL ORDER NO. 1

Effective February 1, 1975

EXPLORATORY OPERATIONS

This Order is established pursuant to the authority prescribed in 30 CFR 270.11 and in accordance with 30 CFR 270.78. All exploratory operations other than drilling of exploratory and development wells will be conducted in accordance with the provisions of this Order. All plans for exploratory operations to be conducted shall include provisions for appropriate environmental protection and reclamation of disturbed lands. A cultural resources investigation approved by the Area Geothermal Supervisor (Supervisor) shall be performed prior to any surface disturbance other than Casual Use.

All variances from the requirements specified in this Order shall be subject to approval pursuant to 30 CFR 270.48. Each Notice of Intent to Conduct Geothermal Resources Exploration Operations shall include a notation of any proposed variances from the requirements of this Order. References in this Order to approvals, determinations, or requirements are to those given or made by the Supervisor or his delegated representative.

The following exploratory operations and reasonable expenditures therefor will qualify as diligent exploration if approved by the Supervisor prior to the initiation of such operations.

1. Casual Use. Casual Use shall include any entrance on the leased lands for geological reconnaissance or surveying purposes. Sampling of springs and water wells on the lease for geochemical analysis shall be construed as casual use. Such non-disturbing surveys and reconnaissance operations will not require a Notice of Intent to Conduct Geothermal Resources Exploration Operations. The lessee shall notify the Supervisor prior to commencing such casual use operations. Casual Use operations proposed or completed shall be included in any subsequent Plan of Operations.

2. Geophysical Exploration. Geophysical exploration shall include, but is not limited to, surface electrical resistivity surveys, seismic ground noise surveys, passive micro-earthquake monitoring surveys, magneto-telluric surveys and all other geophysical surveys, including airborne techniques.

Geophysical surveys other than airborne techniques will require a Notice of Intent to Conduct Geothermal Resources Exploration Operations, (Form 3200-9). All such anticipated surveys should be included in the Plan of Operations and must be approved by the Supervisor before the work is begun.

The lessee shall furnish the Supervisor two copies of the records of such surveys within 30 days after the completion of such operations.

3. Drilling of Shallow Holes. Drilling of shallow holes for the measurement of temperature gradients or heat flow will be considered as an exploration operation and will require approval of a Notice of Intent to Conduct Geothermal Resources Exploration Operations (Form 3200-9) by the Supervisor. The following stipulations shall apply to the drilling of such shallow holes:

A. Holes for measuring temperature gradients shall be limited to a depth of 152 metres (500 feet), unless otherwise authorized by the Supervisor.

B. Return-line temperatures shall be taken at no less than 9-metre (30 foot) intervals during drilling operations on shallow holes drilled with mud. If return-line mud temperature should reach 52°C. (125°F.), drilling ahead shall cease immediately and the hole will be either

(1) Completed as an observation hole by running steel tubing as deep as possible, filling the annulus with drilling mud from total depth to 3 metres (10 feet) below the surface and with cement from 3 metres (10 feet) to the surface;

(2) Abandoned by filling the hole with drilling mud from total depth to 3 metres (10 feet) below the surface and cement to the surface thereafter, or

(3) Equipped with mud cooling and wellhead control devices to maintain well control and mud returns temperature at or below 52°C. (125°F.).

C. If flowing steam or hot water at 65°C (150°F.) or greater is encountered, further drilling shall stop immediately and the hole will be either

(1) Completed as an observation hole using steel tubing cemented from total depth to surface; or

(2) Abandoned by plugging with cement from total depth to surface.

D. If cold flowing artesian water is encountered, the hole will be completed as in (C) hereinabove, except that plastic tubing may be used.

If the conditions outlined in (B), (C) or (D) are encountered, the Supervisor shall be notified immediately.

No exceptions to the stipulations of (B), (C) or (D) will be allowed without specific prior permission of the Supervisor.

E. The lessee shall submit the following information with the Notice of Intent to Conduct Geothermal Resources Exploration Operations (Form 3200-9):

(1) The approximate location (to the nearest 30 metres (100 feet) from some identifiable marker or object within the smallest legal subdivision) and hole number or designation of each proposed hole and probable order of drilling;

(2) The type and size of drilling rig;

(3) The proposed drilling program including the drilling system (type of bit and circulating medium), approximate depths and casing (conductor) program for each such hole;

(4) The type of drilling sump and proposed method of sump abandonment at each location;

(5) The approximate time that each hole will be used for observation; and

(6) The proposed method of abandonment for each hole. Additionally, the lessee shall notify and receive the approval of the Supervisor prior to any change in the location of an approved hole or for any additional holes which the lessee desires to drill.

F. Locations proposed in natural thermal areas within a 300-metre (1,000-foot) radius of hot springs, fumaroles, or other surface geothermal indicia, or in areas of known artesian water flow, will require a detailed drilling program for each hole, approved by the Supervisor. The Supervisor may require special drilling and completion techniques for such holes (such as cemented surface casing and simple expansion-type blowout preventers) to safely control formations containing geothermal or other resources which may be penetrated.

G. A supply of mud and lost circulation material shall be kept on hand while drilling to control abnormal pressure if rotary equipment is used.

H. Holes shall be completed for observation purposes in a manner which will allow satisfactory subsequent abandonment. As a minimum, the annular space shall be filled with mud (cuttings and dirt if drilled with air or auger) to 3 metres (10 feet) below the surface and with cement from 3 metres (10 feet) to the surface, and the tubing shall be capped when not in use.

I. Holes shall be abandoned in a manner that will prevent subsurface interzonal migration of fluids and surface leakage. As a minimum, the top 3 metres (10 feet) of tubing below the surface shall be filled with cement. Tubing shall be cut off at ground level or as directed by the Supervisor.

4. Reporting Completion of Exploration Operations. The Notice of Completion of Geothermal Resources Exploration Operations (Form 3200-10) shall be submitted in triplicate, and shall include the following information for each hole drilled:

A. Final hole designation and location;

B. A driller's log noting water table and water aquifers encountered (if determined), and salt, coal beds or other mineral deposits, if present;

C. Method of completion, cementing, and casting and/or tubing used;

D. Complete details of the abandonment procedures;

E. Any information on drilling difficulties or unusual circumstances encountered which would be helpful in assuring future safety of operations or protection of the environment in the area concerned; and

F. Temperature data and logs for each hole surveyed.

5. General. Drilling fluids or cuttings shall not be discharged onto the surface where such discharge might contaminate lakes and perennial or intermittent streams. Excavated pits or sumps used in drilling shall be backfilled as soon as drilling is completed and restored to conform with the original topography. Unattended sumps shall be completely fenced for the protection of the public, domestic animals and wildlife.

6. Notice of Entry. Applicant shall contact the appropriate U. S. Geological Survey Geothermal District Office prior to entry on the land to conduct exploration operations.

Reid T. Stone
Area Geothermal Supervisor

Approved:

Russell G. Wayland,
Chief, Conservation Division

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CONSERVATION DIVISION

GEOTHERMAL RESOURCES OPERATIONAL ORDER NO. 2

Effective February 1, 1975

DRILLING, COMPLETION AND SPACING OF GEOTHERMAL WELLS

This Order is established pursuant to the authority prescribed in 30 CFR 270.11 and in accordance with 30 CFR 270.14, 270.15, and 270.40. All wells shall be drilled in such a manner as to minimize damage to the environment and to protect life, health, property, usable ground waters and geothermal resources.

All exploratory wells drilled for geothermal resources shall be drilled in accordance with the provisions of this Order. Initial development wells drilled for geothermal resources shall be drilled in accordance with the provisions of this Order, and these provisions shall continue in effect until field rules are issued. After field rules have been established by the Area Geothermal Supervisor (Supervisor), development wells in the individual fields shall be drilled in accordance with such rules.

Where sufficient geologic and engineering information is obtained through exploratory drilling, lessees may make application or the Supervisor may request the lessee to submit an application for the establishment of field rules. The Supervisor may issue field rules at any time he deems appropriate upon failure of the lessee to timely file for such field rules.

All wells drilled under the provisions of this Order shall have been included in an exploratory or development Plan of Operations as required under 30 CFR 270.34. Each Application for Permit to Drill (Form 9-331C) shall include all information required under 30 CFR 270.71, and shall include a notation of any proposed variances from the requirements of this Order. All variances from the requirements specified in this Order shall be subject to approval pursuant to 30 CFR 270.48. References in this Order to approvals, determinations, and requirements for submitting of information or applications for approval are to those granted, made or required by the Supervisor or his delegated representative. The lessee shall comply with the following requirements:

1. Well Casing. All wells shall be cased and cemented in accordance with the requirements of 30 CFR 270.15, and the application for permit to drill shall include the casing design safety factors for collapse, tension and burst. The permanent wellhead completion equipment shall be attached to the production casing or to the intermediate casing if the production casing does not reach to the surface except as otherwise authorized by the Supervisor to meet special well conditions. All casing strings reaching the surface shall be cemented at a sufficient

depth to provide adequate anchorage and support for the casing and any blowout prevention equipment required thereon. For the purpose of this Order, the several casing strings in order of normal installation are (1) conductor, (2) surface, (3) intermediate and (4) production strings. The following casing setting depth requirements are general in nature and subject to variations to permit the casing to be set and cemented in a competent formation. The Supervisor's determination of adequate casing setting depths shall be based upon all geologic and engineering factors including apparent geothermal gradients, depths and pressures of the various formations to be penetrated and all other pertinent information about the area. All depths in this Order refer to true vertical depth (TVD) below ground level, unless otherwise specified.

A. Conductor Casing. This casing shall be set at a minimum depth of 15 metres (50 feet) and a maximum depth of 60 metres (200 feet) before drilling into shallow formations suspected or known to contain geothermal resources, non-condensible gases, or other mineral resources or upon encountering such formations.

B. Surface Casing. This casing shall be set at a depth equivalent to or in excess of ten percent of the proposed total depth of the well provided, however, that such setting depth shall be not less than 60 metres (200 feet) nor more than 400 metres (1,300 feet).

C. Intermediate Casing. This casing shall be set at any time when required by well conditions encountered in drilling below the surface casing such as anomalous pressure zones, uncased fresh water aquifers, cave-ins, washouts, lost circulation zones, rapidly increasing thermal gradients or other drilling hazards. If a liner is used as an intermediate string, the lap shall be tested by a fluid entry or pressure test to determine whether a seal between the liner top and the next larger casing string has been achieved. The liner overlap shall be a minimum of 30 metres (100 feet). The test shall be recorded on the driller's log and may be witnessed by the Supervisor. In the event of lap or casing failure during the test, the lap or casing must be repaired or recemented and successfully retested as required by the Supervisor.

D. Production Casing. This casing may be set at the top of or through the potential producing zone and shall be set before completing the well for production. Production casing shall be run to the surface or lapped into the next larger casing string. The liner overlap, if utilized, shall be at least 30 metres (100 feet) and shall be tested, witnessed and recorded as in the case of intermediate casing hereinabove. In the event of lap or casing failure during the test, the lap or casing must be repaired or recemented and successfully retested as required

by the Supervisor. Production casing shall normally be of consistent nominal outside diameter from the surface or from the top of the lap to the casing shoe. The surface casing shall not be used as production casing, unless otherwise authorized by the Supervisor to meet special well conditions.

E. Cementing of Casing. The conductor and surface casing strings shall be cemented with a quantity of cement sufficient to fill the annular space back to the surface. The intermediate casing string shall likewise be cemented back to the surface or to the top of the lap if a liner is used as an intermediate string. Production casing shall be cemented with a high temperature resistant admix, unless waived by the Supervisor and shall be cemented in a manner necessary to exclude, isolate or segregate overlying formation fluids from the geothermal resources zone and to prevent the movement of fluids into possible fresh water zones. Production casing shall be cemented back to the surface or, if lapped, to the top of the lap. A temperature or cement bond log may be required by the Supervisor after setting and cementing the production casing and after all primary cementing operations if an unsatisfactory cementing job is indicated. Proposed well cementing techniques differing from the requirements of this paragraph will be considered by the Supervisor on an individual well basis.

F. Pressure Testing. Prior to drilling out the casing shoe after cementing, all casing strings set to a depth of 152 metres (500 feet) or greater, except for conductor casing, shall be pressure tested to a minimum pressure of 69 bars (1,000 psi) or 0.045 bars/metre (0.2 psi/ft) whichever is greater. All casing strings set at a depth less than 152 metres (500 feet), except for conductor casing, shall be pressure tested to a minimum pressure of 35 bars (500 psi). Such test shall not exceed the rated working pressure of the casing or the blowout preventer stack assembly, whichever is lesser.

In the event of casing failure during the test, the casing must be repaired or recemented until a satisfactory test is obtained. A pressure decline of 10 percent or less in 30 minutes shall be considered satisfactory.

Casing test results shall be recorded on the driller's log and reported to the Supervisor within 30 days after the completion of such test. Advance notice of all casing and lap tests shall be given in sufficient time to enable the Supervisor to be present to witness such tests. The casing and lap test reports shall give a detailed description of the test, including mud and cement volumes, lapse of time between running and cementing casing and testing, method of testing and test results.

G. Directional Surveys.

(1) General. Deviation surveys (inclination from vertical or single shot) shall be taken on all wells during the normal course of drilling at intervals not to exceed 152 metres (500 feet). The Supervisor may require a directional survey giving both inclination and azimuth or a dipmeter to be obtained on all wells. In calculating all surveys, a correction from true north to Lambert-Grid north shall be made after making the magnetic to true north correction. All surveys shall be filed with the Supervisor. Where directional surveys are required, composite surveys shall be filed with the Supervisor showing the interval from the bottom of the conductor casing to total depth.

(2) Vertical Wells. Wells are considered vertical if inclination does not exceed an average of five degrees from the vertical. The Supervisor may require a directional survey giving both inclination and azimuth at intervals not exceeding 30 metres (100 feet) between stations prior to, or upon, setting any casing string or liner (except conductor casing) and at total depth on any vertical well drilled in close proximity to lease boundaries or areas with an unstable land surface, highly faulted or steeply dipping beds, or in areas of suspected abnormal formation pressures.

(3) Directional Wells. Wells are considered directional if inclination exceeds an average of five degrees from the vertical. Directional surveys giving both inclination and azimuth shall be obtained at intervals not to exceed 30 metres (100 feet) between stations prior to, or upon, setting any casing string or liner (except conductor casing) and at total depth.

2. Blowout Prevention Equipment and Procedures. All necessary precautions shall be taken to keep all wells under control at all times, utilize trained and competent personnel, and utilize properly maintained equipment and materials. Blowout preventers and related well control equipment shall be installed, tested immediately thereafter and maintained ready for use until drilling operations are completed. Certain components, such as packing elements and ram rubbers, shall be of high temperature resistant material as necessary. All kill lines, blowdown lines, manifolds and fittings shall be steel and shall have a temperature derated minimum working pressure rating equivalent to the maximum anticipated wellhead surface pressure. Subject to subparagraphs (A) and (B) hereinbelow blowout prevention equipment shall have manually operated gates and hydraulic actuating systems and accumulators of sufficient capacity to close all of the hydraulically-operated equipment and have a minimum pressure of 69 bars (1,000 psi) remaining on the accumulator. Dual control stations shall be installed with a high

pressure backup system. One control panel shall be located at the driller's station and one control panel shall be located on the ground at least 15 metres (50 feet) away from the wellhead or rotary table. Air or other gaseous fluid drilling systems shall have blowout prevention assemblies. Such assemblies may include, but are not limited to, a rotating head, a double ram blowout preventer or equivalent, a banjo-box or an approved substitute therefor and a blind ram blowout preventer or gate valve, respectively. Exceptions to the requirements of this paragraph will be considered by the Supervisor only for certain geologic and well conditions such as stable surface areas with known low subsurface formation pressures and temperatures.

A proposed blowout prevention program and a blowout contingency plan including proposed containment, public health and safety and clean-up measures shall be submitted with the Application for Permit to Drill (Form 9-331C).

A. Conductor Casing. Before drilling below this string, at least one remotely controlled hydraulically-operated expansion type preventer or an acceptable alternative, approved by the Supervisor, including a drilling spool with side outlets or equivalent, shall be installed. A kill line and blowdown line with appropriate fittings shall be connected to the drilling spool.

B. Surface, Intermediate and Production Casing. Before drilling below any of these strings, the blowout prevention equipment shall include a minimum of:

(1) One expansion-type preventer and accumulator or a rotating head;

(2) A manual and remotely controlled hydraulically-operated double ram blowout preventer or equivalent having a temperature derated minimum working pressure rating which exceeds the maximum anticipated surface pressure at the anticipated reservoir fluid temperature;

(3) A drilling spool with side outlets or equivalent;

(4) A fillup line;

(5) A kill line equipped with at least one valve; and

(6) A blowdown line equipped with at least two valves and securely anchored at all bends and at the end.

C. Testing and Maintenance. Ram-type blowout preventers and auxiliary equipment shall be tested to a minimum of 69 bars (1,000 psi) or to the working pressure of the casing or assembly, whichever is the lesser. Expansion-type blowout preventers shall be tested to 70

percent of the above pressure testing requirements.

The blowout prevention equipment shall be pressure tested:

(1) When installed;

(2) Prior to drilling out plugs and/or casing shoes;

(3) Not less than once each week, alternating the control stations; and

(4) Following repairs that require disconnecting a pressure seal in the assembly.

During drilling operations blowout prevention equipment shall be actuated to test proper functioning as follows:

(1) Once each trip for blind and pipe rams but not less than once each day for pipe rams; and

(2) At least once each week on the drill pipe for expansion-type preventers.

All flange bolts shall be inspected at least weekly and re-tightened as necessary during drilling operations. The auxiliary control systems shall be inspected daily to check the mechanical condition and effectiveness and to ensure personnel acquaintance with the method of operation. Blowout prevention and auxiliary control equipment shall be cleaned, inspected and repaired, if necessary, prior to installation to assure proper functioning. Blowout prevention controls shall be plainly labeled, and all crew members shall be instructed on the function and operation of such equipment. A blowout prevention drill shall be conducted weekly for each drilling crew. All blowout prevention tests and crew drills shall be recorded on the driller's log.

D. Related Well Control Equipment. A full opening drill string safety valve in the open position shall be maintained on the rig floor at all times while drilling operations are being conducted. A kelly cock shall be installed between the kelly and the swivel.

3. Drilling Fluid. The properties, use and testing of drilling fluids and the conduct of related drilling procedures shall be such as are necessary to prevent the blowout of any well. Sufficient drilling fluid materials to ensure well control shall be maintained in the field area readily accessible for use at all times.

A. Drilling Fluid Control. Before pulling drill pipe, the drilling fluid shall be properly conditioned or displaced. The hole shall be kept reasonably full at all times, however, in no event shall the annular mud level be deeper than 30 metres (100 feet) from the rotary table when coming out of the hole with drill pipe. Mud cooling techniques shall be utilized when necessary to maintain mud characteristics for proper well control and hole conditioning.

B. Drilling Fluid Testing. Mud testing and treatment consistent with good operating practice shall be performed daily or more frequently as conditions warrant. Mud testing equipment shall be maintained on the drilling rig at all times.

The following drilling fluid system monitoring or recording devices shall be installed and operated continuously during drilling operations, with mud, occurring below the shoe of the conductor casing. No exceptions to these requirements will be allowed without the specific prior permission of the Supervisor:

(1) High-low level mud pit indicator including a visual and audio-warning device;

(2) Degassers, desilters and desanders;

(3) A mechanical, electrical or manual surface drilling fluid temperature monitoring device. The temperature of the drilling fluid going into and coming out of the hole shall be monitored, read and recorded on the driller's or mud log for a minimum of every 9 metres (30 feet) of hole drilled below the conductor casing; and

(4) A hydrogen sulfide indicator and alarm shall be installed in areas suspected or known to contain hydrogen sulfide gas which may reach levels considered to be dangerous to the health and safety of personnel in the area.

C. Monitoring. From the time drilling operations are initiated and until the well is completed or abandoned, a member of the drilling crew or the toolpusher shall monitor the rig floor at all times for surveillance purposes, unless the well is secured with blowout preventers or cement plugs.

4. Well Logging. All wells shall be logged with an induction electric log or equivalent from total depth to the shoe of the conductor easing. The Supervisor may grant an exception to this requirement when well conditions make it impractical or impossible to meet the above requirements.

A. Electric Logs. The lessee shall furnish to the Supervisor two legible exact copies of all logs run, within 30 days after completion of drilling operations on each well. Two copies of field prints of such logs shall be made immediately available to the Supervisor upon his request. Two copies of chemical analyses of geothermal fluids or other similar services performed shall be submitted to the Supervisor within 30 days after such services are completed.

B. Lithologic Logs. Two legible exact copies of core analysis reports and lithologic (mud) logs shall be submitted to the Supervisor within 30 days after the completion of such reports or logs, when such services are used. However, daily logs shall be made available to the Supervisor immediately upon the completion of such daily logs upon his request.

5. Wellhead Equipment and Testing.

A. Completions. All wellhead connections shall be fluid pressure tested to the API or ASA working pressure rating. Cold water is recommended as the testing fluid. Welding of wellhead connections shall be performed by a certified welder using materials in conformance with ASTM specifications.

B. Wellhead Equipment. All completed wells shall be equipped with a minimum of one casinghead with side outlets, one master valve and one production valve, unless otherwise authorized by the Supervisor. All casingheads, Christmas trees, fittings and connections shall have a temperature derated working pressure equal to or greater than the surface shut-in pressure of the well at reservoir temperature. Packing, sealing mediums and lubricants shall consist of materials or substances that function effectively at, and are resistant to, high temperatures. Wellhead equipment, valves, flanges and fittings shall meet minimum ASA standards or minimum API Standard 6A specifications. Casinghead connections shall be made such that fluid can be pumped between casing strings.

C. Testing. Any well showing sustained casinghead pressure or leaking of geothermal fluids between casing strings shall be tested to determine the origin of the failure, when such failure point is not otherwise determinable, and corrective measures shall be taken.

6. Well Spacing. No producing interval of any well shall be located within 30 metres (100 feet) of the outer boundaries of the leased lands, except where approved by the Supervisor. No surface location of a well shall be located within 15 metres (50 feet) of the boundary of any legal subdivision unless otherwise authorized by the Supervisor. The Supervisor may approve or prescribe such well

spacing as he determines to be necessary for the proper development of the geothermal resources in accordance with the provisions of 30 CFR 270.15.

Reid T. Stone
Area Geothermal Supervisor

Approved:

Russell G. Wayland
Chief, Conservation Division

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CONSERVATION DIVISION

GEOTHERMAL RESOURCES OPERATIONAL ORDER NO. 3

Effective February 1, 1975

PLUGGING AND ABANDONMENT OF WELLS

This Order is established pursuant to the authority prescribed in 30 CFR 270.11 and in accordance with 30 CFR 270.14 and 270.45. The lessee shall comply with the following minimum plugging and abandonment procedures for all geothermal resources wells. Oral approvals shall be in accordance with 30 CFR 270.11. All variances from the requirements specified in this Order shall be subject to approval pursuant to 30 CFR 270.48. Each Sundry Notice (Form 9-331) shall include a notation of any proposed variances from the requirements of this Order. References in this Order to approvals, determinations or requirements are to those given or made by the Area Geothermal Supervisor (Supervisor) or his delegated representative.

The lessee shall promptly plug and abandon any well on the leased land that is not in use or demonstrated to be potentially useful. No well shall be abandoned until its lack of capacity for further profitable production of geothermal resources has been demonstrated to the satisfaction of the Supervisor. No well shall be plugged and abandoned until the manner and method of plugging have been approved or prescribed by the Supervisor.

Cement used to plug any geothermal resources well, except that cement or concrete used for surface plugging, shall be placed in the hole by pumping through drill pipe or tubing. Such cement shall consist of a high temperature resistant admix, unless this requirement is waived by the Supervisor in accordance with the particular circumstances existing in that well or area.

Prior to commencing abandonment operations, the Supervisor shall be notified of all such proposed operations.

Each Sundry Notice (Form 9-331) shall include all information required under 30 CFR 270.45 and 270.72. Any bond or rider thereto covering a lease or an individual well thereon, shall remain in full force and effect until the lease or individual well is properly abandoned and the surface properly restored. Written approval of the abandonment must be obtained from the Supervisor before release of any bonds will be recommended.

1. Permanent Abandonment.

A. Uncased Hole. In uncased portions of wells, cement plugs shall be placed to protect all subsurface mineral resources including fresh water aquifers. Such plugs shall extend a minimum of 30 metres

(100 feet) below, if possible, and 30 metres (100 feet) above such aforementioned zones. Cement plugs shall be placed in a manner necessary to isolate formations and to protect the fluids in such formations from interzonal migration or contamination.

B. Open Hole. Where there is open hole (uncased and open into the casing string above), a cement plug shall be placed in the deepest casing string by either (1) or (2) below. In the event lost circulation conditions exist or are anticipated, or if the well has been drilled with air or other gaseous substance, the plug shall be placed in accordance with (3) below.

(1) A cement plug shall be placed across the shoe extending a minimum of 30 metres (100 feet) above and 30 metres (100 feet) below; or

(2) A cement retainer with effective back pressure control set approximately 30 metres (100 feet) above the casing shoe with at least 61 metres (200 feet) of cement below the retainer and 30 metres (100 feet) of cement above.

(3) A permanent bridge plug set at the casing shoe and capped with a minimum of 61 metres (200 feet) of cement.

C. Perforations, Junk, Fish and Collapsed Pipe. A cement plug shall be placed across production perforations, extending 30 metres (100 feet) below (where possible) and 30 metres (100 feet) above the perforated interval. When a cement retainer is used to squeeze cement the perforated interval, the retainer shall be set a minimum of 30 metres (100 feet) above the perforations. Where the casing contains perforations at or below fish, junk or collapsed casing, thereby perventing cleanout operations, a cement retainer shall be set at least 30 metres (100 feet) above such point, and the interval below the retainer shall be squeeze cemented.

D. Casing Shoes, Stubs, Laps, and Liners. No casing shall be cut and recovered without first obtaining the written approval of the Supervisor. A cement plug shall be placed across all casing stubs, laps, liner tops and all casing shoes not protected by an inner casing string. Such plug shall extend a minimum of 15 metres (50 feet) below and 15 metres (50 feet) above any such shoe, stub, lap or liner top.

E. Plugging of Annular Space. All open annuli extending to the surface shall be plugged with cement.

F. Surface Plug. The innermost casing string which reaches ground level shall be cemented or concreted to a minimum depth of 15 metres (50 feet)measured from 2 metres (6 feet) below ground level.

G. Testing of Plugs. The hardness and location of cement plugs placed across perforated intervals and at the top of uncased or open hole shall be verified by setting down with tubing or drill pipe a minimum of 6,803 kilograms (15,000 pounds) weight on the plug or the maximum weight of the available tubing or drill pipe string, if less than 6,803 kilograms (15,000 pounds).

H. Mud. The intervals of the hole not filled with cement shall be filled with good quality heavy mud.

2. Surface Restoration. All casing strings shall be cut off at least 2 metres (6 feet) below ground level and capped by welding a steel plate on the casing stub. Cellars, pads, structures and other facilities shall be removed. The surface area shall be restored as specified by the Supervisor in consultation with the appropriate surface management agency.

3. Temporary Abandonment. An uncompleted drilling well that is to be temporarily abandoned shall be mudded and cemented as required hereinabove for permanent abandonment except for the provisions of subparagraphs E, F, and I.

4. Suspended Wells. The drilling equipment shall not be removed on any geothermal resources well where drilling operations have been suspended, either temporarily or indefinitely, without prior approval of the Supervisor and after approved measures have been taken to close the well and to protect all subsurface resources, including fresh water aquifers.

Reid T. Stone
Area Geothermal Supervisor

Approved:

Russell G. Wayland,
Chief, Conservation Division

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CONSERVATION DIVISION

GEOTHERMAL RESOURCES OPERATIONAL ORDER NO. 4

Effective August 1, 1975

GENERAL ENVIRONMENTAL PROTECTION REQUIREMENTS

This Order is established pursuant to the authority prescribed in 30 CFR 270.11 and in accordance with 30 CFR 270.2, 270.34(k), 270.37, 270.41, 270.42, 270.43, 270.44, and 270.76. Lessees shall comply with the provisions of this Order. All variances from the requirements specified in this Order shall be subject to approval pursuant to 30 CFR 270.48. References in this Order to approvals, determinations, or requirements are to those given or made by the Area Geothermal Supervisor (Supervisor) or his delegated representative.

All data submitted under this Order shall be available for inspection in accordance with the Freedom of Information Act of 1966 (P.L. 89-487), as amended in 1974 (P.L. 93-502), except information such as geological, geophysical, reservoir, trade secrets, and financial data and interpretations of such data, maps, and related files for which a lessee requests proprietary status; provided that such status is determined by the Supervisor to be warranted and is approved by appropriate officials of the Department of the Interior.

Protection of the environment includes the lessee's responsibility to: conduct exploration and development operations in a manner that provides maximum protection of the environment; rehabilitate disturbed lands; take all necessary precautions to protect the public health and safety; and conduct operations in accordance with the spirit and objectives of all applicable Federal environmental legislation and supporting executive orders.

Adverse environmental impacts from geothermal-related activity shall be prevented or mitigated through enforcement of applicable Federal, State, and local standards, and the application of existing technology. Inability to meet these environmental standards or continued violation of environmental standards due to operations of the lessee, after notification, may be construed as grounds for the Supervisor to order a suspension of operations.

The lessee shall be responsible for the monitoring of readily identifiable localized environmental impacts associated with specific activities that are under the control of the lessee. Monitoring of environmental impacts may be conducted by the use of aerial surveys, inspections, periodic samplings, continuous recordings, or by such other means or methods as required by the Supervisor. Due to the differing natural environmental conditions among geothermal areas, the extent and frequency of such monitoring activities will be determined by the Supervisor on an individual basis. In the event the Supervisor determines that the degree and adequacy of existing environmental protection regulations in certain areas are insufficient, the Supervisor may establish additional and more stringent requirements by the issuance of field orders or by modifying existing orders.

Lessees shall provide for acquisition of environmental baseline data as required in accordance with 30 CFR 270.34(k) for a period of one year prior to submission of a plan for production. Techniques and standards to be used by the lessee for meeting these requirements shall receive prior approval by the Supervisor.

1. Aesthetics. The lessee shall reduce visual impact, where feasible, by the careful selection of sites for operations and facilities on leased lands. The design and construction of facilities shall be conducted in a manner such that the facilities will blend into the natural environmental setting of the area by the appropriate use of landscaping, vegetation, compatible color schemes, and minimum profiles. Native plants or other compatible vegetation shall be used, where possible, for landscaping and revegetation.

2. Land Use and Reclamation. Operating plans shall be designed so that operations will result in the least disturbance of land, water, and vegetation. Existing roads shall be used where suitable. Entry upon certain environmentally fragile land areas, as designated by the surface management agency, may be either seasonally restricted or restricted to special vehicles or transportation methods which will minimize disturbance to the surface or other resources as specified by the Supervisor and surface management agency.

Operating plans shall provide for the reclamation and revegetation of all disturbed lands in a manner approved by the Supervisor and the appropriate surface management agency. Land

reclamation may include preparation and seeding with prescribed wildlife food and plant cover or improved and acceptable substitutes thereof which will equal or enhance the food values for indigenous wildlife species and domesticated animals. Temporary fencing for such reclaimed areas may be required to facilitate restoration thereof.

The lessee shall at all times maintain the leased lands in a safe and orderly condition and shall perform the operations in a workmanlike manner. The lessee shall remove or store all supplies, equipment, and scrap in a timely and orderly fashion.

Operations under a geothermal lease shall not unreasonably interfere with or endanger operations under any other lease, license, claim, permit, or other authorized use on the same lands.

3. Public Access. The public shall have free and unrestricted access to geothermal leased lands, excepting however, where restrictions are necessary to protect public health and safety or where such public access would unduly interfere with the lessee's operations or the security thereof. The lessee shall provide warning signs, fencing, flagmen, barricades, or other safety measures deemed necessary by the Supervisor to protect the public, wildlife, and livestock from hazardous geothermal or related activities.

4. Recreation. Recreational values shall be adequately protected through planning and designing of site development to minimize the aesthetic degradation of the particular recreation area. The lessee shall generally be restricted from surface locations for drilling and other lease operations within 61 metres (200 feet) of established recreation sites and access routes thereto. However, the lessee may relocate a recreational site and/or access routes thereto when approved by the Supervisor with the concurrence of the land management agency.

5. Slope Stability and Erosion Control. Operations shall be conducted in such a manner so as to minimize erosion and disturbance to natural drainage. The lessee shall provide adequate erosion and drainage control to prevent sediments from disturbed sites from entering water courses for soil and natural resource conservation protection.

Mitigating measures to lessen environmental damage may include reseeding of disturbed soils, chemical stabilization, and dust and erosion control on well sites, roads, and construction areas.

All operating plans shall give proper consideration to the potential hazards of slope instability. Where potentially unstable ground conditions exist, design of proposed roads, drill sites, and surface facilities shall be approved by and constructed under the supervision of a qualified engineer or engineering geologist satisfactory to the Supervisor.

6. Biota. The lessee shall conduct all operations in such a manner as to afford reasonable protection of fish, wildlife, and natural habitat. The lessee shall take such measures as are necessary for the conservation of endangered and threatened species of flora and fauna as set forth in applicable executive orders, regulations, and State or Federal legislation such as the Endangered Species Act of 1973 and the Fish and Wildlife Coordination Act. When such species would be adversely affected by the lessee's operations on the leased lands, the lessee shall implement those measures necessary to minimize or eliminate such adverse effects and to protect the flora and fauna as specified by the Supervisor in accordance with recommendations by appropriate Federal and State agencies. Such measures may be in addition to provisions set forth in the lease or accompanying stipulations.

The Supervisor may receive information from recognized experts that a delicate balance of flora and/or fauna exists in the area of operations or proposed operations. Upon receiving such notice, the Supervisor will request timely advice and assistance from appropriate Federal and State agencies regarding: (1) an assessment of the status of flora and fauna in the area which may be adversely affected by operations, and (2) advice as to reasonable mitigating measures appropriate to minimizing or preventing adverse trends in populations, growth, vegetative recovery, or repopulations in potentially affected flora and/or fauna. Based on timely receipt of advice from appropriate agencies, the Supervisor will direct the lessee to take appropriate measures to minimize significant adverse trends in flora and fauna. Such measures may include, but not be limited to, revegetation with grasses, shrubs, or other vegetation of high forage values desirable for habitat, replacement of fauna where lost, replacement of water supply, or sources where destroyed.

Where the lessee's operations have destroyed significant flora and/or fauna or their natural habitat and replacement by natural processes will not take place in a normal growth cycle, the lessee shall take reasonable measures to replace those species or their habitat with the same or other acceptable species or habitat as directed by the Supervisor. The Supervisor's requirements shall be based on recommendations and advice received from appropriate Federal and State agencies.

7. Cultural Resources Preservation. The lessee shall exercise due diligence in the conduct of his operations to protect and preserve significant archaeological, historical, cultural, paleontological, and unique geologic sites. The lessee shall not disturb any known cemetery or burial ground of any group or culture.

Previously unknown sites uncovered by the lessee shall be immediately reported to the Supervisor, and operations on the particular site shall cease until said site can be assessed for its archaeological value and preservation. Necessary controls and remedial actions for the protection and preservation of cultural resources shall be issued on an individual site basis by the Supervisor as warranted.

The preservation, restoration, maintenance, and nomination of all resources for purposes of the National Register of Historic Places shall be in accordance with the provisions of Executive Order 11593 (36 FR 8921) entitled, "Protection and Enhancement of the Cultural Environment," or any amendments thereto.

8. Subsidence and Seismicity. Surveying of the land surface prior to and during geothermal resources production will be required for determining any changes in elevation of the leased lands. Lessees shall make such resurveys as required by the Supervisor to ascertain if subsidence is occurring. Production data, pressures, reinjection rates, and volumes shall be accurately recorded and filed monthly with the Supervisor as provided in 30 CFR 270.37. In the event subsidence activity results from the production of geothermal resources, as determined by surveys by the lessee or a governmental body, the lessee shall take such mitigating actions as are required by the lease terms and by the Supervisor.

If subsidence is determined by the Supervisor to present a significant hazard to operations or adjoining land use, then the Supervisor may require remedial action including, but not limited to, reduced production rates, increased injection of waste or other fluids, or a suspension of production.

A. Surveys. All required surveys shall be second order or better and shall be conducted under the direct supervision of a registered civil engineer or licensed land surveyor using equipment acceptable by the National Ocean Survey for second order surveys. All such work shall be coordinated with the county surveyor of the county in which the surveys and bench marks are to be established. Level lines and networks shall be tied to available regional networks.

Adjusted survey data shall be filed with the Supervisor within 60 days after leveling is completed. Any

lessee having a commercially productive geothermal well or wells shall participate in cooperative County/State subsidence detection programs. All survey data filed with the Supervisor shall be available to the public.

B. Bench Marks. One or more wellsite bench marks shall be required at each completed well prior to prolonged production and said bench marks shall be located in a manner such that there is a minimal probability of destruction or damage to said bench marks. Wellsite bench marks shall be tied to existing regional networks. Additional bench marks between the wellsites and the regional network shall be at 0.8-km (one-half mile) intervals or as otherwise specified by the Supervisor. These bench marks shall be resurveyed during well production operations on a periodic basis as determined by the Supervisor.

Acceptable bench marks include, but are not limited to, a brass rod driven to refusal or 9 metres (about 30 feet) and fitted with an acceptable brass plate or a permanent structure with an installed acceptable brass plate.

C. Reservoir Data. Initial reservoir pressure and temperature shall be reported to the Supervisor in duplicate on Well Completion or Recompletion Report (Form 9-330C) for all completed wells within 30 days after the completion of measurements or tests conducted for the purpose of obtaining such data. Initial production test data including steamwater ratio, surface pressure and temperature, quality, and quantity of well effluent shall also be filed with the Supervisor on Form 9-330C within 30 days after a well is completed.

D. Seismicity. The installation of seismographs or other like instruments in producing geothermal areas for the purpose of detecting potential seismic activity may be initiated from time to time by appropriate public agencies. Lessees shall cooperate with the appropriate public agencies in this regard. The lessee and the appropriate public agency should take care not to unreasonably interfere with or endanger each other's respective operations. The Supervisor shall coordinate such detection programs between the appropriate public agency conducting the program and the lessee.

Where induced seismicity caused by the production of geothermal fluids is determined to exist by the Supervisor, then the Supervisor may require the lessee to install such monitoring devices as necessary to adequately quantify the effects thereof. If induced seismicity is determined to represent a significant hazard, the Supervisor may require remedial

actions including, but not limited to, reduced production rates, increased injection of waste or other fluids, or suspension of production.

9. Pollution, Waste Disposal, and Fire Prevention. The lessee shall comply with all applicable Federal and State standards with respect to the control of all forms of air, land, water, and noise pollution, including the control of erosion and the disposal of liquid, solid, and gaseous wastes. The Supervisor may, at his discretion, establish additional and more stringent standards. Plans for disposal of well effluents must be approved by the Supervisor before any implementation action is undertaken. Immediate corrective action shall be taken in all cases where pollution has occurred.

The lessee shall timely remove or dispose of all waste including human waste, trash, refuse, and extraction and processing waste generated in connection with the lessee's operations in a manner acceptable to the Supervisor.

The lessee shall provide safeguards to minimize potential accidental fires and shall instruct field personnel in fire-prevention methods. The lessee shall maintain fire-fighting equipment in working order at strategic locations on the leased lands.

A. Pollution Prevention. In the conduct of all geothermal operations, the lessee shall not contaminate any natural waters and shall minimize adverse effects on the environment.

(1) Liquid Disposal. Liquid well effluent or the liquid residue thereof containing substances, including heat, which may be harmful or injurious and cannot otherwise be disposed of in conformance with Federal, State, and regional standards, shall be injected into the geothermal resources zone or such other formation as is approved by the Supervisor.

Toxic drilling fluids shall be disposed of in a manner approved by the Supervisor and in conformance with applicable Federal, State, and regional standards.

(2) Solid Waste Disposal. Drill cuttings, sand, precipitates, and other solids shall be disposed of as directed by the Supervisor either on location or at other approved disposal sites. Containers for mud additives for chemicals and other solid waste materials shall be disposed of in a manner and place approved by the Supervisor.

(3) Air Quality. Noncondensible gases such as carbon dioxide, ammonia, and hydrogen sulfide may be vented or ejected into the atmosphere, provided, however, that the volume and the measured concentration of such vented gas or gases shall not exceed applicable Federal, State, or regional air pollution standards. Copies of each permit issued by the appropriate air pollution control agency and the reports required thereunder shall be submitted to the Supervisor.

(4) Pits and Sumps. Pits and sumps shall be lined with impervious material and purged of environmentally harmful chemicals and precipitates before backfilling. In no event shall the contents of a pit or sump be allowed to contaminate streams, lakes, and ground waters. Pits and sumps shall be constructed in a manner and in such locations so as to minimize damage to the natural environment and aesthetic values of the lease or adjacent property. When no longer used or useful, pits and sumps shall be backfilled and the premises restored to as near a natural state as reasonably possible. Temporary fencing of unattended pits and sumps to protect wildlife, livestock, and the public may be required by the Supervisor and the surface management agency.

(5) Production Facilities Maintenance. Production facilities shall be operated and maintained at all times in a manner necessary to prevent pollution. The lessee's field personnel shall be instructed in the proper maintenance and operations of production facilities for the prevention of pollution.

B. Inspection and Reports. Lessees shall comply with the following pollution inspection and reporting requirements.

(1) Pollution Inspections. Drilling and production facilities shall be inspected daily by the lessee. Appropriate preventative maintenance shall be performed as necessary to prevent failures and malfunctions which could lead to pollution. Wells and areas not under production shall be inspected by the lessee at intervals prescribed by the Supervisor. Necessary repairs or maintenance shall be made as required.

(2) Pollution Reports. All pollution incidents shall be reported orally within 18 hours to the appropriate Geothermal District Supervisor and shall be followed within 30 days thereof by a written report stating the cause and corrective action taken.

C. Injection. The use of any subsurface formation, including the geothermal resources zone for the disposal of well effluent, the residue thereof, or the injection of fluids

for other purposes such as subsidence prevention shall not be permitted until the lessee has submitted a plan of injection covering the proposed injection project and has subsequently received the Supervisor's written approval thereof.

(1) Plan of Injection. The plan of injection shall include the quantity, quality, and source of the proposed injection fluid; the means and method by which the fluid is to be injected; a structure map contoured on the intended injection zone; and cross-sections showing producing well locations and the proposed injection well location(s).

(2) Injection Report. The lessee shall file in duplicate with the Supervisor a Monthly Water Injection Report in a form approved by the Supervisor. The subject report shall be filed on or before the last day of the month following the month in which the injection took place.

(3) Inspection. Injection wells and facilities shall be inspected by the lessee at intervals as prescribed by the Supervisor to ascertain that all injected fluids are confined to the approved injection zone. A spinner survey, a radioactive tracer survey, and a cement bond log may be required on each injection well within 30 days after injection begins. The lessee shall furnish to the Supervisor two legible exact copies of any and all such surveys and logs. In the event of a casing failure, inadequate annular cement, or other mechanical failure, the lessee shall without unreasonable delay repair, suspend, or abandon the well. Where failure occurs in a zone which may damage surface or fresh water aquifers, injection shall immediately cease.

(4) New Wells. The drilling of new injection wells in accordance with an approved plan of injection shall be in conformance with the provisions of GRO Order No. 2. An Application for Permit to Drill, Form 9-331C, shall be filed in triplicate and approved for each injection well.

(5) Conversions. The conversion of an existing well to an injection well in accordance with or modification of an approved plan of injection shall be in conformance with the requirements of GRO Order No. 2. The lessee shall demonstrate to the satisfaction of the Supervisor by appropriate testing and logging that the well is mechanically sound and suitable for injection purposes. A Sundry Notice, Form 9-331, shall be filed in triplicate and approved for each conversion.

10. Water Quality. The primary responsibility for water quality and pollution control has been delegated to the States where such States have standards approved by the Environmental

Protection Agency. Such State standards must meet basic Federal requirements prohibiting the deterioration of waters whose existing quality is higher than established water quality standards. The lessee shall comply with the State water quality control organization's standards in such States as have federally-approved standards. The Supervisor, at his discretion, may establish additional and more stringent standards.

The lessee shall file, in duplicate, a detailed water analysis report for all completed geothermal wells within 30 days after completion and annually thereafter or as otherwise specified by the Supervisor. Unless otherwise prescribed by the Supervisor, such analyses shall include a determination of arsenic, boron, radioactive content, and radioactivity of the produced fluids. In the event that a health hazard exists, the Supervisor shall require appropriate health and safety precautions, periodic monitoring, or the suspension of production.

11. Noise Abatement. The lessee shall minimize noise during exploration, development, and production activities. The method and degree of noise abatement shall be as approved by the Supervisor.

The lessee shall conduct noise level measurements during exploration, development, and production operations to determine the potential objectionability to nearby residents as well as the potential health and safety danger due to noise emissions.

Noise level measurements and accompanying data shall be filed with the Supervisor. Such data shall provide the basis for operational and noise control decisions by the Supervisor and shall be based on an assessment of the noise relative to Federal or State criteria including adjustments for the area involved, meteorological conditions, and the time of day of the noise occurence.

The lessee shall comply with Federal occupational noise exposure levels applicable to geothermal activity under the Occupational Safety and Health Act of 1970 as set forth in 29 CFR 1910.95, which are incorporated herein by reference, or with State standards for protection of personnel where such State standards are more restrictive than Federal standards.

A. Measurement Condition. Outdoor noise measurements shall be made at least 3 metres (10 feet) from structures, facilities, or other sound reflecting sources and approximately 1 metre (3 feet) above ground level. Extreme weather conditions, electrical interference, and unusual background noise levels shall be avoided or given due consideration when measuring sound levels.

B. Measurements. The lessee shall monitor and measure noise levels using an octave band noise analyzer with an A-weighted frequency response or a standard sound level meter that conforms to the requirements set forth in USA Standard Specifications for General Purpose Sound Level Meters USASI S1.4-1961 or the latest approved revision thereof. Bandpass filters shall conform to the requirements of USASI S1.11-1966. The lessee shall measure noise level frequency distribution as required by the Supervisor. Sound levels shall be measured in conformance with the USA Standard-Method for the Physical Measurement of Sound USASI S1.2-1962.

C. Criteria. In the absence of more restrictive criteria as may be established in this paragraph, the lessee shall not exceed a noise level of 65 dB(A) for all geothermal-related activity including but not limited to, exploration, development, or production operations as measured at the lease boundary line or 0.8 km (one-half mile) from the source, whichever is greater, using the A-weighted network of a standard Sound Level Meter. However, the permissible noise level of 65 dB(A) may be exceeded under emergency conditions or with the Supervisor's approval if written permission is first obtained by the lessee from all residents within 0.8 km (one-half mile).

D. Assessment. The lessee shall be responsible for taking such noise level measurements as are deemed necessary by the Supervisor. The background noise level shall serve as the criterion for the rating and assessment, by the Supervisor, of the objectionableness of noise emission from a particular source. The background or ambient noise is defined hereby as the minimum sound level at the relevant place and time in the absence of the source noise and shall include consideration for the type of land use, the season, atmospheric conditions, and the time of day.

E. Attenuation. To attenuate objectionable noise, the lessee shall utilize properly designed muffling devices as required by the Supervisor.

F. Relationships. Reference levels and relationships for noise measurements shall be as follows:

(1) Reference sound pressure for airborne sounds shall be 20 MN/m (20 micronewtons per square metre).

(2) Reference power shall be 10-12 watts.

(3) Sound levels shall be measured using a standard Sound Level Meter with an "A" frequency response characteristic (weighting network).

(4) Sound level meter controls shall be set for as uniform a frequency response as possible when measuring sound pressure levels.

(5) Octave band noise levels shall be reported in equivalent A-weighted levels.

G. Record of Sound Measurements. The Supervisor may require sound level measurements during drilling, testing, and producing operations. Such measurements shall be filed in duplicate with the Supervisor and shall include the following data:

(1) Date, time, and location.

(2) Name of observer.

(3) Description of primary noise source emitter under test.

(4) Kind of operation and operating conditions.

(5) Description of secondary noise sources including location, type, and kind of operation.

(6) Type and serial numbers on all microphones, sound level meters, and octave band analyzers used. Length and type of microphone cables.

(7) Position of observer.

(8) Direction of arrival of sound with respect to microphone orientation.

(9) Approximate temperature of microphone.

(10) Results of maintenance and calibration tests.

(11) Weighting network and meter speed used.

(12) Measured overall response and band levels at each microphone position and extent of meter fluctuation.

(13) Background overall response and band levels at each microphone position with primary noise source not operating.

(14) Cable and microphone corrections.

(15) Any other pertinent data such as personnel

exposed directly and indirectly, time pattern of the exposure, atmospheric conditions, attempts at noise control, and personnel protection.

Reid T. Stone
Area Geothermal Supervisor

APPROVED:

Russell G. Wayland
Chief, Conservation Division

☆GPO 695-811

APPENDIX IX

PUBLIC AND GOVERNMENT AGENCY RESPONSES

3200

District Office
P.O. Box 550
Prineville, Oregon 97754

November 6, 1974

Roy H. Sampsel
Special Assistant to the Secretary
P.O. Box 3621
Portland, Oregon 97208

SAMPSEL

Dear Sir:

The Prineville District is in the process of writing an environmental analysis for geothermal leasing of national resource lands in the Glass Butte area of central Oregon. The lands are in Deschutes, Lake, and Harney counties and the analysis will be coordinated with the Burns District.

We are interested in obtaining information concerning possible impacts brought about by geothermal leasing. If you are aware of potential impacts, please contact us.

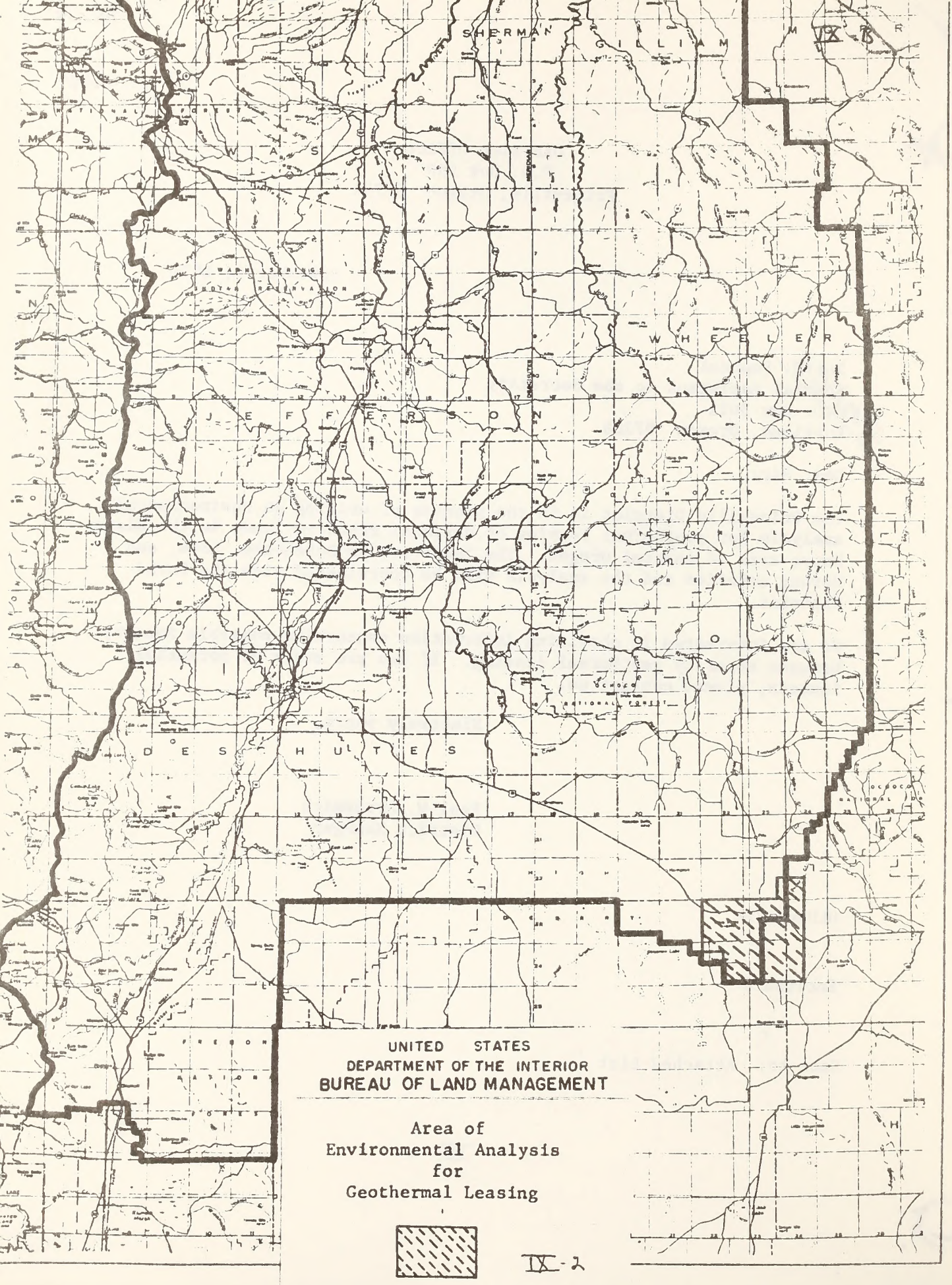
Sincerely yours,

Paul W. Arrasmith
District Manager

DLDavis/ps

Enclosure

Sent to: Attached List


SHERMAN
WASCO
WHEELER
JEFFERSON
DESCHUTES
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
Area of
Environmental Analysis
for
Geothermal Leasing

Roy H. Sampsel
Special Assistant to the Secretary
Pacific Northwest Region
P.O. Box 3621
Portland, Oregon 97208

James L. Agree, Administrator
Environmental Protection Agency
Region X
1200 - Sixth Avenue
Seattle, Washington 98101

T. A. Schlapfer, Regional Forester
Forest Service, USDA - Region 6
Attention: Zean Moore
P.O. Box 3623
Portland, Oregon 97208

Dr. Thomas E. Kruse
State Fisheries Director
Fish Commission of Oregon
307 State Office Building
Portland, Oregon 97201

Charles Shipp
Section of Powersite Lands
Bureau of Power
Federal Power Commission
825 N. Capitol Street
Washington, D. C. 20426

Donald H. Reese, Regional Supervisor
Division of River Basin Studies
Fish and Wildlife Service
1500 NE Irving Street - P.O. Box 3737
Portland, Oregon 97208

John Welch, Realty Specialist
Bureau of Reclamation - Box 043
Boise, Idaho 83724

A. J. Webber, State Conservationist
Soil Conservation Service
1218 SW Washington
Portland, Oregon 97205

OSPIRG
408 SW 2nd
Portland, Oregon 97204

Oregon High Desert Study Group
c/o Coleen Gooding
St. Paul, Oregon 97137

Mr. Larry Williams
Executive Director
Oregon Environmental Council
2637 S.W. Water
Portland, Oregon 97201

USGS Conservation Division
Attention: Geothermal Supervisor
345 Middlefield Road
Menlo Park, California 94025

Mr. Raymond Corcoran
State Geologist
Depart. of Geology and Mineral Industries
1069 State Office Building
Portland, Oregon 97201

Director, State Water Resources Board
1158 Cheneketa N.E.
Salem, Oregon 97301

Director
Oregon Wildlife Commission
P.O. Box 3503
Portland, Oregon 97208

Director
Division of State Lands
502 Winter N.E.
Salem, Oregon 97310

Clearing House
Executive Department
Capitol Building
Salem, Oregon 97310

Curator of Archaeology
Museum of Natural History
University of Oregon
Eugene, Oregon 97403

Director
Oregon State Soil and Water Conser. Comm.
217 Agriculture Building
637 Capitol Street N.E.
Salem, Oregon 97310

Soil Conservation Service
745 Wall
Bend, Oregon 97701

Bureau of Sport Fisheries & Wildlife
West 12th & Trenton
Bend, Oregon 97701

Oregon Wildlife Federation
Room 216
811 S.W. 6th Ave.
Portland, Oregon 97205

Assistant to the Governor
Natural Resources
240 Church S.E.
Salem, Oregon 97310

Chris L. Wheeler
State Engineer
1178 Chemeketa St. NE
Salem, Oregon 97310

Ms. Mary Jane Newton, Secretary
Concerned Citizens for Newberry Crater
11 NW Kansas Avenue
Bend, Oregon 97701

Mr. R.E. Mitchell
South Highway 97
Bend, Oregon 97701

Arlieg Isley
Lake County Extension Agent
Lake County Court House
Lakeview, Oregon 97630

Lake County Planning Commission
Lake County Courthouse
Lakeview, Oregon 97630

Lake County Commissioners
Lake County Courthouse
Lakeview, Oregon 97630

Vern Ryan
Brothers, Oregon 97712

H. L. Elkins
833 South Main
Prineville, Oregon 97754

Harney County Planning Commission
Harney County Courthouse
Burns, Oregon 97720

Harney County Commissioners
Harney County Courthouse
Burns, Oregon 97720

Deschutes County Planning Commission
Deschutes County Courthouse
Bend, Oregon 97701

Deschutes County Commissioners
Deschutes County Courthouse
Bend, Oregon 97701

Deschutes County Extension Agent
117 Oregon
Bend, Oregon 97701

IX-F

OFFICE OF THE GOVERNOR
STATE CAPITOL
SALEM 97310

TOM McCALL
GOVERNOR

OCT 1974
RECEIVED
Bureau of
Land Management
Prineville, Ore.

September 27

	ACTION — INFO	
✓	D.M.	
	RES. MGMT.	
	OPERATIONS	
	ADMIN.	
✓	CENTRAL OREGON	
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	DESCHUTES	
	READING	FILE

Mr. Paul W. Arrasmith
District Manager
Bureau of Land Management
P. O. Box 550
Prineville, Oregon 97754

Dear Mr. Arrasmith:

You requested information concerning possible impacts of geothermal leasing in the Glass Butte area for inclusion in an environmental analysis. Enclosed are comments from several of the natural resource agencies in Oregon for your consideration.

We look forward to having the opportunity to review the draft environmental analysis when it is completed. X

Sincerely,

Harold F. Brauner
Assistant to the Governor
Natural Resources

HFB:sn
Encs.

FISH
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State Fisheries Director

September 26, 1974

Mr. Hal Brauner
Governor's Office
State of Oregon
207 State Capitol
Salem, Oregon 97310

Dear Mr. Brauner:

This letter comments on the September 4, 1974 request by the Bureau of Land Management for information on geothermal leasing impacts in Deschutes, Lake and Harney Counties.

We have been notified by the Division of State Lands (August 7, 1974) regarding geothermal lease applications and have coordinated comments with the Wildlife Commission pursuant to the Division of State Lands Geothermal Leasing Rules 75-270 through 75-295.

Regulations of the Department of Geology and Mineral Industries -- OAR 20-005 through 20-170 are binding on geothermal drilling, and consider protection of wildlife resources (20-170). Anticipated impacts of geothermal development are identified in the Environmental Impact Statement for the Geothermal Leasing Program prepared by the U.S. Department of the Interior and issued in final form October 1973. I have enclosed documentation of the Federal leasing program.

In a response to the Oregon Nuclear and Thermal Energy Council Statewide Siting Task Force, the Fish Commission and Wildlife Commission identified general concerns regarding geothermal drilling and energy use. I have enclosed a copy of this document for your use.

SEP 27 REC'D

Mr. Hal Brauner
September 26, 1974
Page 2

Ted Fies of the Wildlife Commission informs me that he has identified specific Wildlife concerns near Glass Buttes area and has forwarded comments in this regard. Since there are no significant streams in the Glass Buttes area, we are not concerned with fishery resources.

Thank you for the opportunity to comment.

Sincerely,

Irv Jones...

IRVING W. JONES
AQUATIC BIOLOGIST

Enclosures

BACKGROUND SYNOPSIS

GEOTHERMAL RESOURCES LEASING PROGRAM

December 1970 - Geothermal Steam Act approved.

January 1971 - A geothermal study was initiated by the Assistant Secretary--Mineral Resources and the Assistant Secretary--Public Land Management.

January 1971 - A Geothermal Task Force was formally established under the direction of the Assistant Secretary--Mineral Resources and the Assistant Secretary--Public Land Management.

July 1971 - Proposed leasing and operating regulations were published in Federal Register.

September 1971 - A Draft Environmental Impact Statement was issued.

May 1972 - Proposed unit plan regulations were published in Federal Register and supplement to Draft Environmental Impact Statement was issued.

November 1972 - Proposed leasing, operating and unit regulations were published in Federal Register.

July 1973 - Proposed leasing operating and unit regulations were republished in Federal Register.

October 1973 - Final Environmental Impact Statement was issued.

December 1973 - Leasing, operating and unit regulations published in Federal Register. Secretary Morton announced lease sales in three Known Geothermal Resources Areas in California.

# # #

INT: 2624-73

CONCERNS OF THE FISH COMMISSION OF OREGON AND OREGON WILDLIFE COMMISSION REGARDING DEVELOPMENT OF GEOTHERMAL ENERGY

In geothermal development, a series of wells are drilled into the ground in promising areas, hopefully producing a dependable supply of hot, dry steam capable of running turbines that spin electric generators.

These wells can also produce elements which are not useful in producing power, and which sometimes have adverse effects on the quality of the environment where they are released. They can include noxious or foul smelling gas, corrosive fluids, water that contains toxic salts or other dissolved metal compounds or minerals, heat, and noise.

Possible Effects of Geothermal Development on Fish and Wildlife

Concerns of the Fish and Wildlife Commissions regarding geothermal energy development are nearly identical to those expressed in relation to other thermal power development. These are protection of stream flow, water quality, spawning grounds, rearing areas and migration routes presently used by resident and anadromous fish, and habitat used by resident and migratory wildlife.

Prediction of the effects of geothermal development on fishery resources is presently subject to much speculation. Based on conditions prevailing at other geothermal developments around the world, the following potential hazards could adversely affect water quality and stream habitat necessary to support existing fish life.

1. Uncontrolled harmful effluents--either thermal or chemical--entering natural streams, lakes, estuaries or ocean waters.
2. Reduced stream flows because of ground water changes.
3. Non-point source pollution such as increased turbidity from disturbed areas of soil.

4. Subsidence of ground near the developed area, influencing stream flow.

It is difficult to predict with accuracy the effect on wildlife simply because we have no actual experience here in Oregon with this type of development. However, based on existing geothermal facilities in other areas of the world, we can list potential areas of concern as follows:

1. Harassment of wildlife from construction and maintenance activities. Location and amount of use of access roads to and from the wells and generating plant sites.
2. Interference with wintering areas and migration routes could be a problem depending on the amount of land required and location of a plant.
3. Noise from a geothermal plant would have some influence on wildlife use of the site. Specific effects are unknown.
4. Transmission facilities would have the greatest impact on wildlife in forested areas. Rights-of-way could be beneficial to wildlife provided the vegetation is managed for wildlife. Transmission line towers should be constructed to prevent electrocution of eagles, hawks, and owls. Right-of-way access roads could lead to an increase in animal harassment by the public. Use of these roads should be controlled, especially during the winter.
5. Threatened or endangered species habitat.

The relative importance of any of these potential adverse impacts depends on the particular site location, and the enforcement of control measures now required by federal and state laws. These laws require the protection of water quality in streams, lakes and marine waters sufficient to maintain a balanced population of native aquatic life.

Some possibilities may exist for use of heat from geothermal sources to increase growth rates of fish in hatcheries or fish farms in winter months when natural water temperatures are below optimum growth levels.

Where specific measures are required for fish and wildlife protection or mitigation, evaluations and recommendations would be developed by the Fish Commission, Oregon Wildlife Commission and other concerned state and federal agencies.

Fish Commission of Oregon
September 25, 1974

IX-M

DEPARTMENT OF ENVIRONMENTAL QUALITY

1234 S.W. MORRISON STREET • PORTLAND, ORE. 97205 • Telephone (503) 229-5356

TOM McCALL
GOVERNOR

KESS CANNON
Director

September 24, 1974

Mr. Harold Brauner
Assistant to the Governor
Natural Resources
240 Cottage Street S.E.
Salem, Oregon 97310

Re: Geothermal leasing in Glass Butte area

Dear Hal:

The following comments are submitted regarding the preparation by the Prineville District of BLM of an environmental analysis for geothermal leasing of national resource lands in the Glass Butte area of Central Oregon.

Unless adequate precautions are taken, geothermal exploration and development in that area could constitute a potential source of water and land pollution through improper discharge or disposal of liquid and solid wastes including pollutant laden geothermal waters, domestic sewage, drill cuttings or mud, garbage, refuse and other waste materials. Geothermal development could also constitute a potential source of air pollution through the release to the atmosphere of excessive quantities of odorous and toxic matter such as hydrogen sulfide. In addition it could constitute a source of noise pollution.

These possible environmental impacts should therefore be thoroughly covered in the environmental analysis being prepared by BLM for federal lands in that area. Any permits issued by the federal government for geothermal

SEP 25 REC'D

Contains Recycled Materials

DEQ-1

exploration and development should specify that the permittee comply fully with the requirements of Oregon Revised Statutes Chapter 454, 459, 467 and 468 pertaining to sewage disposal, solid waste control, noise control and air and water pollution control.

Cordially,

KESSLER R. CANNON
Director

Kenneth H. Spies

Kenneth H. Spies
Assistant Director
Land Quality

KHS:vt

SOIL AND WATER CONSERVATION COMMISSION

20 AGRICULTURE BUILDING • SALEM, OREGON • 97310 • Phone 378-3810

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DIRECTOR
BUD F. A. SVALBERG

September 16, 1974

Mr. Hal Brauner
240 Cottage St., S. E.
Salem, Oregon 97310

Dear Hal:

In regard to the request of the Prineville District, BLM for information concerning possible impacts brought about by geothermal leasing, I submit the following comments.

It is my feeling that Oregon needs to strengthen its position in regards to our geothermal resources. We must clarify the position of the State where geothermal resources are located on public lands, and we must further clarify the position of the private landowner who has such resources on his lands.

We need to know if private individuals will be able to develop this resource on their lands, how this resource will be regulated, and what the parameters of the geothermal development will be. What will be the affect on neighboring private lands?

We must have some idea about soil disturbance, erosion and sedimentation problems during the development, and we must give thought to how the residual mineral salts will be disposed. These are soil erosion and sedimentation problems of considerable magnitude and impact on the environment.

I hope this will help you, Hal.

Sincerely,

Bud F. A. Svalberg

Bud F. A. Svalberg
Director

BFAS:rj

SEP 17 REC'D

INT 7

IX-P

OREGON STATE HIGHWAY DIVISION

HIGHWAY BUILDING • SALEM, OREGON • 97310

TOM McCALL
GOVERNOR

F. B. KLABOE
Administrator of Highways

September 25, 1974

Mr. Hal Brauner
Assistant to the Governor
Natural Resources
240 Church Street S.E.
Salem, OR 97310

Dear Hal:

We have the following comments on the Bureau of Land Management's September 4, 1974, letter on environmental impacts in the Glass Buttes area related to geothermal leasing:

Provision should be made for public access needs at the most popular rockhounding areas for the glass-like obsidian and for the protection of significant historic or archaeological sites which may exist in this area of extensive Indian occupation and previous use.

There are no existing or planned state parks in the area. There are no historic properties listed on the National Register of Historic Places, or in the Statewide Inventory of Historic Sites and Buildings in the proposed lease area. However, there may be other historic properties in the area which have not been adequately surveyed.

Very truly yours,

David G. Talbot
State Parks Superintendent

cc: Larry Jacobson
Paul Hartwig

SEP 26 REC'D

A DIVISION OF THE DEPARTMENT OF TRANSPORTATION

DRAFT
9/16/74
IX - Q

(date)

Mr. Paul W. Arrasmith
District Manager
Bureau of Land Management
P. O. Box 550
Prineville, Oregon 97754

Dear Mr. Arrasmith:

Under Oregon law, the State Water Resources Board is charged with developing policies and programs for the use of surface waters. Within the area of our statutory concerns, we are aware of no environmental impact specifically related to either a geothermal leasing program or initial geothermal exploration. However, problems in the Glass Butte area could arise in conjunction with geothermal development if large amounts of water are ever required. It is doubtful that additional demands could be met from surface sources and would most likely require utilization of ground water where available.

Therefore, we suggest that in your environmental analysis you might note the overall water situation and that there is a potential for impacts if extensive quantities of water are required for ultimate geothermal development.

Sincerely,

Albert E. Wright
Interim Director

AEW/.

IX-R

WILDLIFE COMMISSION

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JOHN W. McKEAN
Wildlife Director

September 24, 1974

Sept. 1974
RECEIVED
Bureau of Land Management
Prineville, Ore.

Mr. Paul W. Arrasmith
District Manager
Bureau of Land Management
P. O. Box 550
Prineville, Oregon 97754

Dear Mr. Arrasmith:

The following comments are offered in response to your request for information regarding geothermal leasing in the Glass Buttes area.

1. Glass Buttes supports an estimated summer population of 100 and a winter population of about 300 mule deer.

2. Antelope use the lower open slopes on the north side of Glass Buttes, south of Highway 20, as winter range and the Stauffer county southwest of Glass Buttes during the summer.

   The eastern portion of the lease area is also used by antelope. Wintering herds use the area between Glass Buttes and Squaw Butte and north of Highway 20 in Harney, Deschutes and Lake Counties.

3. Except for the mountainous terrain, the entire Glass Buttes area is used by sage grouse.

4. Activity associated with the exploration and development of geothermal resources could have an impact on wildlife. It is imperative that close communication be maintained between industry and resource agencies to identify and resolve any conflicts arising from geothermal power production.

The opportunity to provide comments is appreciated.

Sincerely,

Ted T. Fies

Ted T. Fies, Biologist
Environmental Management Section

cc Hal Brauner
Paul Bonn, OWC
Irv Jones, FCO & Leonard Wilkerson, DSL

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Conservation Division
345 Middlefield Road
Menlo Park, California 94025

April 15, 1974

Memorandum

To: Pacific Area Geologist

From: Geologist, Menlo Park

Subject: Addition of land to Oregon Geothermal Land Classification Map - Glass Buttes area

On the basis of increased geothermal leasing activities and a geologic review of the area, certain land in the Glass Buttes area should be added to the Oregon Geothermal Land Classification Map as valuable prospectively for geothermal steam and associated geothermal resources.

The geology of the proposed additional land has been mapped in a very generalized manner by Trauger (1950) and in a good reconnaissance manner by Walker and others (1967) and Greene and others (1972). The dominent rock types to be found in this area are dikes, plugs, and complex exogenous domes of dacitic to rhyolitic composition (Walker and others, 1967). Surrounding this silicic rock of Pliocene to Pleistocene age are Pliocene lacustrine tuffaceous sandstones and siltstones that are well-to semi-consolidated. Also included in this volcaniclastic unit are welded and nonwelded vitric-crystal and vitric-lithic tuffs, diatomites, and conglomerates. Other rocks in the proposed additional land are thin vesicular basalt flows and mafic vent rocks (basalts and andesites) all of Pliocene and Pleistocene age.

The structure of this area is primarily that of northwest-southeast trending high-angle normal faults dipping either to the north or south. These faults produce horst and graben and "stair-step" structures. However, these faults tend not to exist in the dacitic and rhyolitic rocks of the silicic vents, perhaps indicating the silicic volcanism post-dates active tectonic faulting. Walker and others (1967) projects an inferred, deeply buried transcurrent fault through this proposed area and very near the silicic vent rocks. Perhaps this fault allowed the acid magma to rise to the near surface and produce the rhyolitic rocks.

Peterson and Groh (1967) outlined the geothermal conditions that exist in the Klamath Falls area; that is, a relatively shallow heat source overlain by a pervious water-bearing zone of transmission that is in turn overlain by an impermeable cap rock that does not allow heat or hot water to rise to the surface. Also found in the Klamath Falls area are horst and graben structures. The geologic environment in this proposed additional land at Glass Buttes is very much analogous to the Klamath Falls area. A shallow magma body of Pliocene and Pleistocene age (as evidenced by the presence of rhyolitic rock of the same age) is overlain by lava flows of varying compositions that act as fluid conduits that is in turn overlain in large areas of the proposed additional land by impermeable lacustrine sediments. Also found here are the horst and graben structures that seem to be present and necessary in other geothermal areas.

Another geologic factor that the Glass Buttes area has in common with other geothermal areas is the presence of considerable amounts of mercury in the form of cinnabar. Cinnabar is a vapor phase mineral that is common to geothermal areas such as the Geysers of northern California and Steamboat Springs and other areas in Nevada. Cinnabar has been actively mined in the Glass Buttes area for quite a few years but is not a major producing area.

The following land, totalling about 126,720 acres, should be considered as valuable prospectively for geothermal steam and associated geothermal resources and the land classification map changed accordingly:

Willamette Base and Meridian, Oregon

T. 23 S., R. 22 E.
Secs. 1-36, inclusive

T. 24 S., R. 22 E.
Secs. 1-36, inclusive

T. 22 S., R. 23 E.
Secs. 22-27, 34-36, inclusive

T. 23 S., R. 23 E.
Secs. 1-36, inclusive

T. 24 S., R. 23 E.
Secs. 1-36, inclusive

T. 22 S., R. 24 E.
Secs. 19-21, 28-33, inclusive

T. 23 S., R. 24 E.
Secs. 4-9, 16-21, 28-33, inclusive

T. 24 S., R. 24 E.,
Secs. 4-9, 16-21, 28-33, inclusive

References:

Greene, R. C., Walker, G. W., and Corcoran, R. E., 1972, Geologic map of the Burns quadrangle, Oregon: U. S. Geol. Survey Misc. Geol. Inv. Maps I-680, scale 1:250,000.

Peterson, N. V., and Groh, E. A., 1967, Geothermal potential of the Klamath Falls area, Oregon, a preliminary study: Ore Bin, vol. 29, no. 11, p. 209-231.

Trauger, F. D., 1950, Factual ground-water data in Lake County, Oregon: U. S. Geol. Survey in coop. with Oregon State Engineer, unpub. rept., 287 p.

Walker, G. W., Peterson, N. V., and Greene, R. C., 1967, Reconnaissance geologic map of the east half of the Crescent quadrangle, Lake, Deschutes, and Crook Counties, Oregon: U. S. Geol. Survey Misc. Geol. Inv. Map I-493, scale 1:250,000.

William H. Lee

Approved: _____
Area Geologist

_____
Date

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Conservation Division
345 Middlefield Road
Menlo Park, California 19425

(X) ACTION — INFO
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October 3, 1974

Memorandum

To: District Manager, Bureau of Land Management, Prineville, Oregon

From: Area Geothermal Supervisor

Subject: Environmental Analysis Record, Glass Butte Area, Oregon

In reference to your letter of September 4, 1974, please find attached a very brief summary of the Geology of the Glass Buttes region. It is our determination that no exceptional geologic hazards should be encountered in the subject area.

Reid T. Stone

Enclosure
RR:fb

GEOLOGY OF THE GLASS BUTTES AREA OF CENTRAL OREGON

The Glass Buttes area of Central Oregon is included in the High Lava Plains province. Glass Buttes itself is a rhyolite dome complex marking a probable vent for late Pliocene or early Pleistocene flows and flow breccias of dacitic to rhyolitic composition. These flows are deposited on lacustrine tuffaceous sedimentary rocks of Pliocene age and basalt flows of early Pliocene age. More recent basalt flows of the Newberry Volcano predominate to the west and occur also to the east of Glass Buttes. Most of the basalt flows are associated with broad shield volcanos of low relief, although many basaltic eruptions in the high lava plains occurred sporadically along fissures (Walker, 1969).

Structurally, the province is dominated by the northwest-trending Brothers fault zone, a relatively broad belt of en echelon normal faults of moderate to small displacement. Glass Buttes is situated within this fault zone. Walker (1969) believes that the Brothers fault zone may overlie a deeply buried strike slip fault, the normal faults only representing adjustment of the surface and near surface rocks to deeper lateral movements.

Although some faults are shown penetrating Holocene sediments (Walker, Peterson & Greene, 1967 and Greene, Walker & Corcoran, 1972) the area is presently considered to be one of low-level seismic activity.

In conclusion, with regard to geologic hazards, the impact of geothermal exploration and development should be minimal. Landslides and other forms of mass movement are not inherent problems of the area. While faults in the region must be considered earthquake capable, the general level and degree of seismicity, as stated above, is very low. Existence of these faults, in itself, should not serve as a deterrent to orderly, carefully planned development should exploration warrant further action.

References:

Walker, G. W., Geology of the High Lava Plains Province: Mineral and Water Resources of Oregon, 1969, pp 77-79.

Walker, G. W., Peterson, N. V. and Green, R. C., 1967, Reconnaissance Geologic Map of the East Half of the Crescent Quadrangle, Lake, Deschutes and Crook Counties.

Green, R. E. Walker, G. W. and Corcoran, R. E., 1972 Geologic Map of the Burns Quadrangle, Oregon

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DESCHUTES
LAKE CO
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QTb
QTsv
Benjamin Lake
Qp
4845
Ranch
Stauffer
QTb
Qp
QTb
Twt
QTsv
QTp
QTps
Tob
QTmv
QTps
Qal
Qp
Sand hill
QTps
CHRISTMAS LAKE VALLEY
Qp
QTps

IX-Y

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State Fisheries Director

November 13, 1974

Mr. Paul W. Arrasmith
District Manager
U.S. Department of the Interior
Bureau of Land Management
District Office
P. O. Box 550
Prineville, Oregon 97754

Dear Mr. Arrasmith:

3200

Concerns of the Fish Commission regarding geothermal leasing in the Glass Butte area are minimal. We will, therefore, defer comment to the Oregon Wildlife Commission.

Sincerely,

Irving W. Jones

IRVING W. JONES
AQUATIC BIOLOGIST

cc Oregon Wildlife Commission

IX-2

DIVISION OF STATE LANDS

Sept

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September 11, 1974

Mr. Paul W. Arrasmith
Bureau of Land Management
P. O. Box 550
Prineville, OR 97754

Dear Mr. Arrasmith:

Thank you for notifying us of your work on an environmental impact report for geothermal leasing of national resource lands. As you know there are state-owned lands in the report interest areas which are subject to leasing by this agency. Under our leasing rules, the applicant for a state geothermal lease must provide a satisfactory environmental impact report before a lease can be issued.

We expect that state geothermal applicants in your study areas will provide us a report within the next 120 days, which could make a significant contribution to your effort. We will advise them of your project so that they may coordinate any extensive examination of environmental features with your work.

As other information pertaining to the environment or to geothermal development comes to our attention, we will try to provide it to you. Please call us if you need any specific information pertaining to state lands.

Sincerely yours,

DIVISION OF STATE LANDS
William S. Cox, Director

Leonard G. Wilkerson

Leonard G. Wilkerson
Minerals Leasing Specialist

LGW/dr

IX-AA

Concerned Citizens for
Newberry Crater
11 NW Kansas Avenue
Bend, Oregon 97701
September 13, 1974

Sept 1974 Bureau of Land Management Prineville, Ore.

Paul W. Arrasmith, District Manager
Bureau of Land Management, District Office
P. O. Box 550
Prineville, Oregon 97754

Dear Mr. Arrasmith,

In regards to your letter of September 4, 1974 concerning the writing of an environmental analysis for geothermal leasing in the Glass Butte area, we have several things to note:

1. If this area is actively exploited, traffic hazards could develop along highway 20, especially in winter, from water vapors condensing into fog blankets and ice.

2. Though land subsidence would probably occur, in that area it would most likely not be too important.

3. Water pollution from surface spills, contamination of ground water, or lowering of water tables could be a problem to local ranchers.

4. Mercury may be found in the geothermal fluids in that vicinity, as mercury is mined in the area. This could constitute a health hazard if it is found to be above 5.0 parts per billion. "Mercury can become methylated in the natural environment and become incorporated into the body tissues of organisms. Mercury can then accumulate up the food chain until it reaches toxic concentrations". This quote is from Energy from Geothermal Resources -- report prepared for the Subcommittee on Energy of the Committee on Science and Austronautics -- U.S. House of Representitives, 93rd Congress, second session. Page 68.

Your letter was also referred to the Deschutes Geology Club, since the area in question incorporates all of the Glass Butte Recreational Rockhound Area. Their reaction -- and we are sure this would also reflect the feelings of the North West Federation of Mineralogical Societies as well -- was that they have no objection to geothermal development so long as they continued to have access to this favorite rockhounding and arrowhead hunting site. If access were to be denied, however, we are sure you would get quite an adverse reaction from the public.

We hope this letter will be of some help to you,

Yours truly,
Mary Jane Newton

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
~~BUREAU OF SPORT FISHERIES AND WILDLIFE~~

1500 N. E. IRVING STREET
P. O. BOX 3737
PORTLAND, OREGON 97208

Reference: RB

December 10, 1974

To: District Manager, District Office, Bureau of Land Management, Prineville, Oregon

From: Regional Director, FWS, Portland, Oregon

Subject: Glass Butte Geothermal Leasing Area

This is in response to your letter of November 6, in which you requested our comments on geothermal leasing sites in the Glass Butte area, Deschutes, Lake, and Harney Counties, Oregon.

The potential leasing sites occur in high plateau desert habitat. Glass Butte, surrounded by several smaller buttes, rises to an elevation of 6,385 feet above sea level. The higher elevations in this area contain good stands of mountain mahogany intermixed with hardwood and juniper. Grasses occur throughout and are cropped by cattle, as well as by wildlife. Ground cover, however, is generally sparse. Coyotes, rabbits, and several species of small rodents, as well as an assortment of birds, commonly inhabit the area. More significantly, Glass Butte supports a winter mule deer herd of approximately 300 animals and a summer herd of approximately one-third that number. The area is on the fringe of the pronghorn antelope range and may be visited from time to time by those animals. No permanent natural water occurs, although there is at least one small reservoir and there are several stock watering troughs scattered around the lower elevations.

Probable impacts on the environment of this area by geothermal development can be summarized as the loss of habitat which may occur for a multitude of reasons during both exploration for and development of the geothermal resource.

Losses during exploration will occur as a result of the physical presence of men and equipment. This impact will be manifested by removal of vegetation for access roads, well installation, sump pits, and service areas associated with exploratory wells. Losses may also occur secondarily by rain and sump overflow on soils that have been disturbed by exploration activities. The soil in this area is extremely fragile and subject to erosion, as evidenced along existing roads.

Vegetative changes may also be expected where exploration is accompanied by leakage of high salinity fluids, unless these are adequately controlled.

Presence of men and equipment will tend to lower the desirability of surrounding habitat. Displacement of animals can cause further problems as contiguous habitat becomes overburdened, or as animals are shifted to unfavorable habitat. Particularly in the case of larger animals, disruption of the environment may unfavorably affect a population's seasonal dependence of this area and subsequently reduce the numbers of that population in areas remote from the lease site.

Impacts involving vegetation removal can be reversed, in time, after abandonment of the area. Erosion, however, will be more difficult to control and may precipitate widespread habitat disruption. Because of the mountainous nature of the terrain in this site, erosion may be a very significant problem.

To minimize adverse environmental impacts, we recommend the following: that areas of high erosion probability be defined and be designated as nonentry areas; that leases be required to use existing roadways as much as possible; and that lessees be required to revegetate disturbed soil at abandoned drill sites and elsewhere. We also recommend that mountain mahogany, hardwood, and juniper stands be identified, that generous perimeters around these areas be described, and that they be designated as nonentry areas.

Developmental phases of geothermal activities may be expected to continue the environmental impacts described for exploratory phases. However, these impacts will be expanded consistent with expanding site activity. Impacts may be expected to be much more widespread with the erection of permanent buildings, transmission lines, and various support facilities. In order for us to evaluate the expected development, we will require information on the magnitude, actual site locations, and type of developments and the character and amount of waste and by-products.

We appreciate the opportunity to provide these comments.

R. Kahler Martinson

R. Kahler Martinson

IX-DD

United States Department of the Interior
BUREAU OF RECLAMATION
PACIFIC NORTHWEST REGIONAL OFFICE
FEDERAL BUILDING & U.S. COURTHOUSE
BOX 043-550 WEST FORT STREET
BOISE, IDAHO 83724

IN REPLY REFER TO: 426

(X) ACTION — INFO (X)	
D.M.	MCA
RES. MGMT.	
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ADMIN.	
✓ CENTRAL OREGON	
✓ Dennis	
DESCHUTES	
READING	FILE

DEC 4 1974

Mr. Paul W. Arrasmith
District Manager
Bureau of Land Management
P.O. Box 550
Prineville, Oregon 97754

Dear Mr. Arrasmith:

This is in response to your letter of November 6, 1974, in which you asked for any information we might have concerning possible impacts brought about by geothermal leasing. We have had no experience with geothermal exploration on Reclamation lands in this Region and therefore have no actual data on the impact that might be expected. However, we have been informed that most geothermal sources have environmental problems that include dissipation of unused heat, noise, air pollution (hydrogen sulfide and ammonia), land subsidence, and brine disposal. Extensive drilling is usually required before the actual extent of geothermal potential is known.

In view of the many problems associated with geothermal exploration, it would seem that considerable activity could be expected in areas where actual exploration takes place. Such activity could certainly affect wildlife in the area, as well as cattle and sheep grazing on the land. It is also possible that surface damage could occur which would be detrimental to future agricultural production. It is our understanding that the actual production of geothermal energy would require considerably more surface use of the land than is normally needed for production of oil and gas.

We are not familiar with the Glass Butte area of Central Oregon for which you are currently preparing an environmental analysis for geothermal leasing. However, we do have lands in your District that may be included in future geothermal lease applications.

Sincerely yours,

Larry Vinson Hale

Acting Regional Supervisor of
Water & Land Operations

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IX - FE

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Conservation Division
345 Middlefield Road
Menlo Park, California 94025

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OCT 1974
RECEIVED
Bureau of Land Management
Prineville, Ore.

October 1, 1974

Memorandum

To: Paul Easmith, District Manager
Bureau of Land Management, Prineville, Oregon

From: Area Geothermal Supervisor

Subject: Environmental Analysis Record, Glass Butte Area, Oregon

In response to your letter of September 1, 1974, we are sending you a copy of the sections contained in the Final Environmental Statement for the Geothermal Leasing Program which discuss the environmental impacts normally asociated with geothermal leasing and the mitigating measures which are usually applied.

Not included in EAR

In addition, we are in the process of reviewing the subject area to determine any exceptional geological hazards which may be encountered. Our findings will be forwarded to you under separate cover.

Reid T. Stone

Reid T. Stone

Enclosure

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Environmental analysis
record for Glass Butte

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